# Women, environmental changes and forestry-related development:
## Gender-affected roles of rural people in land degradation and environmental rehabilitation in a dry region of Sudan

Anu Eskonheimo

Academic dissertation

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Supervisors: Professor Olavi Luukkanen
Viikki Tropical Resources Institute (VITRI)
Department of Forest Ecology
University of Helsinki
Finland

Professor Timo Myllyntaus
School of History
University of Turku
Finland

Reviewers: Docent Ritva Kivikkokangas-Sandgren
Department of Geography
University of Helsinki
Finland

Dr. Patricia Daley
School of Geography
University of Oxford
United Kingdom

Opponent: Professor Harri Siiskonen
Department of History
University of Joensuu
Finland

ENGLISH ABSTRACT

The purpose of the present study was to increase understanding of the interaction of rural people and, specifically, women with the environment in a dry area in Sudan. The study that included nomadic pastoralists and farmers, aimed at answering two main research questions, namely: What kinds of roles have the local people, and the women in particular, had in land degradation in the study area and what kinds of issues would a gender-sensitive, forestry-related environmental rehabilitation intervention need to consider there?

The study adopted the definition of land degradation as proposed by the United Nations Convention to Combat Desertification (UNCCD), which describes *land degradation as reduction or loss the biological or economic productivity and complexity of land in arid, semi-arid and dry sub-humid areas*. The Convention perceives *desertification* as land degradation.

The dry study area in Sudan, South of Sahara, has been the subject of land degradation or desertification discussions since the 1970s, and other studies have been also conducted to assess the degradation in the area. Nevertheless, the exact occurrence, scale and local significance of land degradation in the area is still unclear. This study explored how the rural population whose livelihood depended on the area, perceived environmental changes occurring there and compared their conceptions with other sources of information of the area such as research reports.

The main fieldwork methods included interviews with open-ended questions and observation of people and the environment. The theoretical framework conceptualised the rural population as land users whose choices of environmental activities are affected by multiple factors in the social and biophysical contexts in which they live. It was emphasised that these factors have their own specific characteristics in different contexts, simultaneously recognising that there are also factors that generally affect environmental practices in various areas such as the land users' environmental literacy (conceptions of the environment), gender and livelihood needs.

The people studied described that environmental changes, such as reduced vegetation cover and cropland production, had complicated the maintenance of their livelihoods in the study area. Some degraded sites were also identified through observations during the fieldwork. Whether a large scale reduction of cropland productivity had occurred in the farmers' croplands remained, however, unclear.

The study found that the environmental impact of the rural women's activities varied and was normally limited. The women's most significant environmental impact resulted from their cutting of trees, which was likely to contribute, at least in some places, to land degradation, affecting the environment together with climate and herded animals. However, when a wider perspective is taken, it becomes questionable whether the women have really played roles in land degradation, since gender, poverty and the need to maintain livelihood had caused them to conduct environmentally harmful activities. The women have had, however, no power to change the causes of their activities.

The findings further suggested that an inadequate availability of food was the most critical need in the study area. Therefore, an environmental programme in the area was suggested to include technical measures to increase the productivity of croplands, income generation opportunities and readiness to co-operate with other programmes to improve the local people's abilities to maintain their livelihoods.

In order to protect the environment and alleviate the women's work burden, the introduction of fuel-saving stoves was also suggested. Furthermore, it was suggested that an increased planting of trees on homesteads would be supported by an easy availability of tree seedlings. Planting trees in common property land was, however, perceived as extremely demanding in the study area, due to scarcity of such land. In addition, it became apparent that the local land users, and women in particular, needed to allocate their labour to maintain the immediate livelihood of their families and were not motivated to allocate their labour solely for environmental rehabilitation.

Nonetheless, from the point of view of the existing social structures, women's active participation in a community-based environmental programme would be rather natural, particularly among the farmer women who had already formed a women's group and participated in communal decision making. Forming of a women group or groups was suggested to further support both the farmer women's and pastoral women' active participation within an environmental programme and their general empowerment. Finally, it was, nevertheless, stressed that an environmental programme would need to acknowledge that improving rural people's well-being and maintaining their livelihood in the study area requires development and co-operation with various sectors in Sudan.

Key words: Sudan, drylands, land degradation, gender, environmental literacy, environmental rehabilitation, livelihoods, forestry, poverty

## SUOMENKIELINEN TIIVISTELMÄ/FINNISH ABSTRACT

Tutkimuksen päämääränä oli lisätä ymmärrystä siitä, millaisella tavalla ihmiset olivat vuorovaikutuksessa ympäristönsä kanssa tutkitulla kuivalla alueella Sudanissa. Tutkimuksessa oli mukana alueella asuvia paimentolaisia ja maanviljelijöitä. Siinä etsittiin vastauksia kahteen pääasialliseen tutkimuskysymykseen: Millaisia rooleja paikallisilla ihmisillä, erityisesti naisilla, oli ollut ympäristön muutoksissa tutkimusalueella sekä millaisia asioita tulisi sosiaalisen sukupuolen huomioonottavan, ympäristön kunnostamiseen ja metsänhoitoon liittyvän ympäristöohjelman ottaa siellä huomioon?

Tutkimus keskittyi maa-alueen köyhtymiseen, joita kuvattiin englanninkielisellä termillä land degradation. Tutkimuksessa ymmärrettiin *maa-alueen köyhtyminen* samoin kuin se on määritelty YK:n aavikoitumisen torjuntaan liittyvässä sopimuksessa (United Nations' Convention to Combat Desertification eli UNCCD), jossa se on määritelty *maan biologisen tai taloudellisen tuoton ja kompleksisuuden menetykseksi tai vähentymiseksi kuivilla, puoli-kuivilla ja kuivilla puolikosteilla alueilla* (dry sub-humid areas). Sopimuksessa termi aavikoituminen (desertification) määriteltiin myös tarkoittamaan maa-alueen köyhtymistä.

Puolikuiva tutkimusalue Sudanissa, Saharan eteläpuolella, on ollut vuosikymmeniä aavikoitumiskeskustelun kohteena. Ympäristön muutoksia ja mahdollista aavikoitumista on myös tutkittu alueella 1970-luvulta lähtien. Maa-alueen köyhtymisen tarkka esiintyminen, laajuus ja paikallinen merkitys tutkimusalueella on kuitenkin edelleen epäselvää. Tässä tutkimuksessa selvitettiin erityisesti sitä, miten paikallinen väestö jonka toimeentulo on riippuvainen alueesta, hahmotti tutkimusalueella tapahtuneita ympäristön muutoksia. Paikallisia käsityksiä ympäristön muutoksista verrattiin kuitenkin myös muihin tietolähteisiin alueen ympäristöstä, kuten tutkimusraportteihin.

Kenttätyön pääasiallinen menetelmä oli tutkittavien ihmisten haastatteleminen, joissa käytettiin avoimia kysymyksiä. Sen lisäksi menetelmiin kuului esimerkiksi ihmisten ja ympäristön havainnointia. Teoreettinen viitekehys käsitteellisti paikalliset ihmiset ympäristön käyttäjinä, jotka tekivät valintoja siitä miten he hyödyntävät ympäristöään. Näihin valintoihin puolestaan vaikuttivat ne fyysiset ja sosiaaliset kontekstit, joissa he elävät. Teoriassa painotettiin, että nämä kontekstit tulee tuntea eri alueilla, ennen kuin selityksiä voidaan antaa niistä tekijöistä, jotka ovat vaikuttaneet ihmisten tekemiin valintoihin ympäristöä hyödyntävien aktiviteettien suhteen. On kuitenkin myös olemassa tekijöitä jotka vaikuttavat ihmisten vuorovaikutukseen ympäristön kanssa yleisesti eri alueilla kuten

toimeentuloon liittyvät tarpeet, sosiaalinen sukupuoli (gender) ja ympäristön lukutaito.

Tutkittavat ihmiset esittivät, että ympäristön muutokset kuten vähentynyt kasvillisuus ja viljelymaiden alentunut tuotantokyky, olivat vaikeuttaneet heidän toimeentuloaan tutkimusalueella. Tämän lisäksi myös tutkija havainnoi tutkimusalueella paikkoja, jotka olivat näkyvän köyhtymisen kohteena. Se, kärsivätkö alueen viljelymaat laajamittaisesta köyhtymisestä jäi kuitenkin epäselväksi.

Tutkimuksesta kävi ilmi, että tutkimusaluetta hyödyntävien naisten toiminnan ympäristövaikutukset vaihtelivat eri naisten kesken ja olivat yleisesti ottaen rajalliset. Naisten toiminnan merkittävin ympäristövaikutus oli seurausta siitä, että he hyödynsivät alueen puita, mikä todennäköisesti vaikutti varsinkin tietyillä paikoilla tutkimusaluetta, yhdessä ilmaston ja alueella laidunnettujen eläinten kanssa, maa-alueen köyhtymistä lisäävästi. Se, oliko naisilla ylipäätään selkeää roolia tai rooleja maa-alueen köyhtymisessä tutkimuskohteessa voidaan kuitenkin kyseenalaistaa, jos sen tilannetta tarkastellaan laajemmasta perspektiivistä. Naisten ympäristölle haitalliseen toimintaan oli nimittäin vaikuttanut tekijöitä, joita he eivät olleet pystyneet muuttamaan, kuten sosiaalinen sukupuoli, köyhyys ja tarve saada toimeentulo tietyissä olosuhteissa.

Haastattelujen mukaan suurin ongelma tutkimusalueella oli ruuan riittämättömyys. Tästä syystä ympäristöä kunnostavan ohjelmaan ehdotettiin otettavaksi mukaan teknisiä toimenpiteitä viljelymaiden tuottavuuden lisäämiseksi, mahdollisuuksia ansaita tuloja ja valmiutta tehdä yhteistyötä muiden sellaisten kehitysohjelmien kanssa, jotka keskittyvät paikallisten ihmisten hyvinvoinnin lisäämiseen ja toimeentulon turvaamiseen.

Ympäristön suojelemiseksi ja naisten työtaakan helpottamiseksi ehdotettiin myös polttopuuta säästävien liesien sisällyttämistä ympäristöohjelmaan. Sen lisäksi ehdotettiin, että maanviljelijöiden puiden istuttamista tuettaisiin taimien helpolla saatavuudella. Puiden istuttamista yleisesti käytetylle, ei-yksityiselle maalle pidettiin kuitenkin erittäin vaikeana, koska alueella on pulaa tällaisesta maasta. Tutkimuksesta ilmeni myös, että paikallisten ihmisten ja erityisesti naisten on suunnattava työvoimansa siihen, että heidän perheidensä välitön toimeentulo turvataan, eivätkä he täten ole motivoituneita uhraamaan aikaa ja vaivaa pelkästään ympäristöä kunnostavaan toimintaan.

Kuitenkin, jos sosiaaliset rakenteet huomioidaan, naisten aktiivinen osallistuminen yhteisöpohjaiseen ympäristöohjelmaan olisi varsin luontevaa varsinkin tutkituille

maanviljelijänaisille, jotka olivat jo muodostaneet naisten ryhmän ja osallistuneet yhteisönsä päätöksentekoon. Jotta naisten aktiivisuutta ja vaikutusvallan lisäämistä, "voimistamista" (empowerment) tuettaisiin myös ympäristöohjelmassa, ehdotettiin ohjelmaan liittyvän naisryhmän tai naisryhmien muodostamista sekä maanviljelijänaisten että paimentolaisnaisten keskuudessa. Ympäristöohjelman tulisi kuitenkin tunnustaa myös se, että ihmisten hyvinvoinnin kehittäminen ja toimeentulon turvaaminen tutkimusalueella edellyttää usean sudanilaisen yhteiskunnan sektorin mukana oloa.

Avainsanat: Sudan, kuivat alueet, maan köyhtyminen, sosiaalinen sukupuoli, ympäristön lukutaito, ympäristön kunnostaminen, metsänhoito, elinkeinot, köyhyys

Author's address/ kirjoittajan yhteystiedot:
Anu Eskonheimo, Viikki Tropical Resources Institute (VITRI), P.O Box 27 (Latokartanonkaari 9), FI-00014 University of Helsinki, Finland. E-mail anu.eskonheimo@helsinki.fi. Telephone : + 358 9 191 58650, fax: + 358 9 191 58646

PREFACE

Since the early 1980s, numerous Finnish and international researchers working at the Viikki Tropical Resources Institute (VITRI) have conducted forestry-related studies in Sudan, mainly with support from the Academy of Finland and the Ministry for Foreign Affairs of Finland. This study is part of this lively Sudan research.

The researcher is grateful to various institutions, which provided financial support for this study. The funding that was received from Sasakawa Peace Foundation in 2002 enabled the initial study and fieldwork. The most significant financial support was provided by the University of Helsinki, since during 2003-2005 the study was conducted as part of the research programme "Environmental Literacy – Perceiving Nature in Cultural and Historical Context" led by the Department of Social Science History. Finally, support from Graduate School in Forest Sciences led by University of Joensuu enabled the completion of the study in 2006. The study benefited from the joint supervision received from VITRI and Department of Social Science History in University of Helsinki.

I would like to express my deepest gratitude to my supervisor in VITRI, Professor Olavi Luukkanen. Owing to his encouragement and personal interest in multidisciplinary research, I had the courage to engage myself in this study and he has been very supportive throughout the whole research process. Moreover, I am particularly grateful and indebted to my other supervisor Timo Myllyntaus, Professor in the School of History at Turku University and docent in the Department of Social Science History at University of Helsinki, who allocated a considerable amount of his time to this study and gave me numerous valuable comments and advices.

I would like to also thank the reviewers of this thesis, Dr. Ritva Kivikkokangas-Sandgren from University of Helsinki and Dr. Patricia Daley from University of Oxford, for their professionalism and constructive, extremely useful comments. I would also like to thank the Language Services in the University of Helsinki for corrections made in the English language and Ms. Sylvia Akar from the Institute for Asian and African Studies at University of Helsinki, who advised me in the transliteration of the Arabic words.

Moreover, I am indebted to Dr. Mohamed El Fadl in VITRI whose support was particularly important in the planning phase of the thesis and crucial in the preparation of the fieldwork. He also offered me an opportunity to live with his family in Khartoum, where I had the first experiences of the hospitality of the people in Sudan. The contribution of Dr. Leena Kirjavainen was also crucial during the

planning phase of this study. I was tremendously lucky to have her friendly support and useful advice, based on her long international career, often involving gender matters, and her work experience in Sudan.

I am also most grateful to Dr. Abdalla Gaafar Mohamed and his wife Ms. Samira Abdel Samad, who not only gave me professional advice, but also showed me great friendliness and hospitality. I first met Samira Abdel Samad in El Obeid, where she offered me a home with her family. Living with this amiable family was one of those wonderful experiences in my life that I will never forget. When I returned from Sudan I met Abdalla Gaafar Mohamed, who had travelled to Finland from Sudan to complete his doctoral research in VITRI. We had many discussions together and he was always ready to help me and to answer my many questions.

In Sudan, the administrative and logistical support provided by Professor Ahmed Ali Salih and his staff from the Forestry Research Centre (FRC) and Dr. Abdelazim M. Ibrahim and his staff in Forests National Corporation (FNC) was essential in order to prepare and conduct the fieldwork successfully. I was helped by numerous staff members; thank you all! I would like to, however, thank specifically Ms. Sawsan Abdalla Ali from FRC who allocated a great deal of her time to help me and introduced me to her family. I would also like to express my gratitude to Dr. Mohamed El Mukhtar Ballal from the Agricultural Research Centre (ARC) in El Obeid, with whom I discussed the study area and from whom I learned many things. His professional support, friendship and his family's hospitality supported a lot my work. I am also extremely grateful to Mr. Osama Tagelsir from FNC, who helped me to organise my transport and also many other practical matters.

When conducting my fieldwork, I was lucky to find the two most helpful and skilful research assistants, Ms. Selwa Ali Ebrahim who worked with me with nomadic pastoralists and Ms. Hanan Hassan who assisted my work with the farmers. I would like to thank both of them for fantastic work, which was absolutely crucial for the fieldwork. Thank you for also being my friends! I will never forget either one of you.

Furthermore, a number of researchers in Finland and elsewhere have helped me to find references and provided ideas for this study. Thank you for your time! All my colleagues in VITRI have been particularly supportive, always ready to share their professional knowledge and personal experiences as researchers. Special thanks to Minna for your friendship and views that have helped me a lot in my work and for Vesa for allocating time whenever possible to comment my texts. I would also like to give my special thanks to Eshetu, for your professional support and your friendship; it has been a great pleasure to share the office with you and to get to know you.

I would also like to thank my friends who have given me the much needed emotional support and encouragement. Special thanks to the girls in "femmariklubi", Elina, Päivi and Sanna, for your friendship, continuous encouragement and professional support. Finally, I would like to express my deepest gratitude to my parents who have always encouraged me in whatever I decided to do and always believed in me. This thesis is dedicated to my partner Reima, who has supported me so incredibly much. I am so lucky to have you in my life, thank you for always being there for me! Thank you also for you very concrete, time-consuming help with the visual lay-out of this research report.

Helsinki, April 2006
Anu Eskonheimo

List of abbreviations

| | |
|---|---|
| ARC | Agricultural Research Corporation |
| CIFOR | Centre for International Forest Research |
| FNC | Forests National Corporation |
| FRC | Forestry Research Centre |
| FAO | Food and Agriculture Organization of the United Nations |
| GAC | Gum Arabic Company |
| GAD | Gender and Development |
| INSTRAW | United Nations International Research and Training Institute for the Advancement of Women |
| ITCZ | Inter-Tropical Convergence Zone |
| NGO | Non-Governmental Organization |
| NIF | National Islamic Front |
| P/PET | (Mean annual) precipitation divided by (mean annual) potential evapotranspiration |
| PLA | Participatory Learning and Action |
| PRA | Participatory Rural Appraisal |
| SEAGA | Socio-economic and Gender Analysis Programme |
| UNCCD | United Nations Convention to Combat Desertification |
| UNCED | United Nations Conference on Environment and Development |
| UNCOD | United Nations Conference on Desertification |
| UNDP | United Nations Development Programme |
| UNEP | United Nations Environment Programme |
| UNESCO | United Nations Educational, Scientific and Cultural Organization |
| UNFPA | United Nations Population Fund |
| UNHCR | United Nations High Commissioner for Refugees |
| UNICEF | The United Nation's Children's Fund |
| UNSO | United Nations Sudano-Sahelian Office |
| WID | Women in Development |

Glossary of Arabic terms

| | |
|---|---|
| *Abbala* | Nomadic pastoralists who herd camels |
| *Andarab* | *Cordia sinensis* Lam. |
| *Baqqara* | Nomadic pastoralists who herd cattle |
| *Hafir* | An excavation for collecting rainwater |
| *Karkadeh* | *Hibiscus sabdariffa* L. |
| *Jawama'a* | Ethnic group of the sedentary farmers studied |
| *Shanable* | Ethnic group of the nomadic pastoralists studied who traditionally herd camels |
| *Fellata* | Ethnic group of nomadic pastoralists studied who traditionally herd cattle |
| *Gardud* | Soil type dominated by clay, but including also sand |
| *Goz* | Soil type with high sand content |
| *Gudim* | *Grewia tenax (Forssk.) Fiori* |
| *Habil* | *Combretum spp.* |
| *Hashab* | *Acacia senegal* (Linn.) Willd. |
| *Hawazma* | Ethnic group of nomadic pastoralists studied who traditionally herd cattle |
| *Higlij* | *Balanites aegyptiaca* (L.) Del. |
| *Neem* | *Azadirachta indica* A. Juss. |
| *Sheikh* | A tribal leader of a community |
| *Sheil* | A type of a loan |
| *Shuteh* | *Combretum spp.* |
| *Sidr* | *Ziziphus spina-christi* (L.) Desf. |
| *Tabaldi* | *Adansonia digiatata* L. |
| *Talih* | *Acacia seyal* Del. |
| *Umda* | Regional tribal leader |

Tables and figures

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# 1. Introduction

## 1.1. Background: Sudan, drylands, environmental changes and rural people

In the spring of 2003, the western world began to hear disturbing reports from Darfur in Sudan describing violent attacks that had caused massive sufferings to the people living in the area. Until recently, a great number of people had died due to the attacks and millions had left their homes to live in the refugee camps in Chad. Sudan, a country that had been earlier known due to its long civil war (see Johnson 2003) and devastating droughts (Teklu et al. 1991, 25-40; de Waal 1997, 91-98), is again tormented by a tragedy.

Nevertheless, although violence and droughts have anguished Sudan, perceiving the whole of Sudan as a permanent emergency area, simplifies the conditions in the country. Sudan is the largest country in Africa with a land area of 25 million $km^2$ (Bradshaw 2002, 156, 288). It has over 35 million people (UNICEF 2006) with diverse ethnic backgrounds living in various circumstances in divergent climate and vegetation zones (Republic of the Sudan 2003, 1-2).

At the same time, Sudan is mainly covered by drylands (Republic of the Sudan 2003, 1-2). Maintaining a livelihood in such areas tends to be demanding. Drylands are characterised by aridity that is caused by limited and erratic precipitation together with high evaporation (Ffoliott et al. 1994; 1-2; UNEP 1997, 6). According to the United Nations Convention to Combat Desertification (UNCCD) drylands include arid, semiarid and dry subhumid areas, which have differing levels of aridity. This aridity is described by the P/PET ratio that is calculated by dividing the mean annual precipitation with the mean annual potential evapotranspiration (potential evaporation from soil plus transpiration by plants). The Convention states that the P/PET ratio varies in the drylands from 0.05 in arid areas to 0.65 in dry subhumid areas. Later, a term hyperarid has been also adopted to describe the areas with P/PET below 0.05 (UNEP 1997, 5).

The term drought refers to situations where precipitation has decreased in an area significantly below the normal recorded levels resulting in serious hydrological imbalances that negatively affect local people's production systems (United Nations1994, 5). Droughts affect drylands and their people so commonly that they are perceived as natural characteristics of such areas (United Nations 1994, 5; Thomas and Middleton 1995, 104; le Houérou 1996, 133). Catastrophic droughts have also occurred in the drylands of Sudan. The drought and subsequent famine

were particularly widespread and severe in 1984 -1985 (Teklu et al. 1991 17-19; de Waal 1997, 87).

Nonetheless, even in times without droughts, the efforts of rural Sudanese to maintain their livelihood in drylands, are complicated by the insufficient and erratic precipitation that affects the productivity of their croplands and availability of vegetation for grazing and browsing for their animals. Although the local people often suffer from environmental changes in drylands, they may harm their environment themselves for example by cutting trees intensively or herding large numbers of animals in a limited area (Olsson and Rapp 1991, 193; Dregne 2002, 110, 122). At the same time, local people also conserve and protect the environment (e.g., Clay et al. 1998, 373; Ballal 2002, 2).

This study is particularly interested in such local activities, exploring both the local activities that have caused the environmental changes and those that have rehabilitated the environment in the study area. Moreover, the factors that had caused the local people to conduct such activities are studied. The study area represents one of many dry regions of Sudan that had been affected by limited and variable precipitation causing environmental changes such as decrease and increase in vegetation cover (Olsson, L. 1985, 147; Mohamed et al. 1995).

The study includes people from two production systems living in the area, namely sedentary farmers and nomadic pastoralists. The term "nomadic pastoralists" refers in this study to all people who do not live settled in one specific place all the year and who earn their main livelihood from keeping animals. Due to a great diversity of nomadic pastoralists' migration patterns and livelihood strategies in the study area, they are not further classified into subgroups in terms that describe more accurately their migration patterns and livelihood strategies. The term nomadic pastoralists covers pastoralists with diverse migration patterns including both those that cultivate part of the year and non-cultivating pastoralists.

When studying how the local people have affected the study area with their environmental activities, this study concentrates mostly on their own views, exploring their perceptions of the occurrence of environmental changes and their own roles in such changes. Moreover, local views of the factors that had affected their environmental practices are also studied. Both local women and men are included in this study, but specific attention is given to rural women to enhance their visibility.

Previously, researchers have studied nomadic pastoralists' and sedentary farmers' perceptions of environmental changes elsewhere. These studies have included

perceptions of changes in soil (Chokor and Odermeho 1994; Niemeijer and Mazzucato 2003, 417-420) and in vegetation cover (Bollig and Schulte 1999; Lykke 2000; Wezel and Haigis 2001; Baars and Aptidon 2002). Michael Bollig and Anette Schulte have also studied people's conceptions of their own roles in environmental changes (see Bollig and Schulte 1999, 498-506).

In this study, the local people's views of environmental changes are compared with outsiders' perceptions of the study area. The term outsiders refers to a diverse group of people, including researchers, development professionals, political rulers and government officials (and in the past, colonialists). Outsiders may discuss various environments, for instance, presenting views about the causes of environmental changes in an area (e.g., Helldén 1991, 380), but they do not live as an integral part of the local, rural community and depend on the discussed environment for their livelihood.

Outsiders' views of various environments have been compared to local views in several studies since the middle of 1990s. In 1996, Melissa Leach and Robin Mearns edited a widely quoted book "The Lie of the Land. Challenging Received Wisdom on the African Environment", where the commonly-shared beliefs that the outsiders had of the environmental changes in Africa were challenged with various empirical studies and local views (Leach and Mearns 1996). Melissa Leach and James Fairhead (Fairhead and Leach 1996) have also compared local conceptions of deforestation in Guinea in Western Africa with outsiders' views in their book "Misreading the African landscape. Society and ecology in a forest-savanna mosaic".

Later, Anne Mette Lykke and others have studied changes of tree cover in Burkina Faso by comparing local people's perceptions with outsiders' aerial photography and botanical investigations (Lykke et al. 1999). In another study in Burkina Faso, Leslie Gray and Philippe Morant studied farmers' views of cropland degradation and compared the local perceptions with scientific data on the soils discussed (Gray and Morant 2003). In Niger, Andrew Warren and others compared farmers' perceptions of erosion with international development and scientific discourses of erosion (Warren et al. 2001). In Australia, Ruth Lane compared local oral histories of environmental changes with other sources of information such as climatic records (Lane 1997). In Honduras, Polly Ericksen and Mario Ardón compared local farmers' knowledge of soils with a soil scientist's knowledge (Ericksen and Ardón 2003).

When comparing local conceptions of the environment with outsiders' views, this study is aware that conceptions of an area may differ between local people and outsiders (see Siebers 2004, 42; Nygren 2004, 195-200) and that various views tend to exist inside these groups as well. Nonetheless, local people's and outsiders'

environmental conceptions are believed to significantly guide environmental practices in rural tropical areas and consequently, they are an important topic of this research.

This study analyses environmental conceptions with the support of a revised *environmental literacy* concept that had been described by Minna Hares and others as referring to *people's conceptions of physical environment* (Hares et al. 2006, 129). This literacy is constructed by personal learning processes, affected by various factors in an individual's ecological and social circumstances. People's environmental literacy can manifest itself directly, for example in their sustainable environmentally behaviour. This does not, however, always occur. The reason is that in addition to environmental literacy, environmental behaviour is affected by various other factors such as livelihood considerations (Hares et al. 2006, 129-130).

Therefore, understanding the reasons behind people's environmental literacy and practices requires knowledge of their social and biophysical circumstances, which have been previously studied in many areas to explain human/environment interaction (Mortimore 1989; Llahiane 1996; Agarwal 1997a; Mortimore and Adams 2001; Siebers 2004). This study report will later theorise, analyse and discuss how the circumstances in the area studied had affected the rural people's environmental practices. Next, this chapter will nevertheless concentrate on the types of environmental changes the present study covers, introducing the term land degradation. After that, the idea of rehabilitating drylands with trees is introduced. Then, the chapter introduces the role of Sudanese women as environmental managers and, at the end, presents the research questions.

## 1.2. Land degradation

The term land degradation has been used to describe certain environmental changes in drylands. The term is so commonly used in ecological and international development discussions that it was also adopted in this study – although it has been used in variable ways. The term is often connected to another widely-used term to describe environmental changes in drylands, namely desertification. The United Nations Convention to Combat Desertification (UNCCD) describes *desertification* as *"land degradation in arid, semi-arid and dry sub-humid areas".* The Convention describes *land degradation* as: "*the reduction or loss, in arid, semi-arid and dry sub-humid areas, of the biological or economic productivity and complexity of rainfed cropland, irrigated cropland, or range, pasture, forest and woodlands...* " (United Nations 1994, 4-5).

In short, the Convention thus equals desertification to land degradation, which refers to decrease in land production. In this study, the term land degradation is understood in a similar manner. In addition, it is stressed that land degradation is perceived to differ from "normal", precipitation-affected vegetation changes in dry regions so that land degradation is understood as a more permanent situation where a land does not fully "recover" from poor rainfall periods (see Thomas and Middleton 1997, 128-130; Dougill and Cox 1995, 1). The term *land* is understood as a broad concept describing a terrestrial area as a whole including, for instance, the soil and vegetation (United Nations 1994, 5).

Hence, land degradation is a wider concept than the term soil degradation, which solely describes the soil that has become degraded. This study nevertheless assumes that soil degradation tends to be part of land degradation and studies of soil degradation can be conducted to indicate land degradation. Soil erosion is one of the processes that may degrade soils, which is why its occurrence has been studied to indicate land degradation (Warren et al. 2001, Warren 2002). The term soil erosion refers to a process where either the wind or water (or both) removes soil particles from their places. In conjunction with the soil erosion, organic material and nutrients from the soil are thus removed, which may result a decrease in the productivity of soils (UNEP 1997, 26). Erosion may also have negative off-site impacts, since drifting sand may harm agricultural land elsewhere and even contribute to dust storms travelling hundreds of kilometres from their source (UNEP 1997, 26).

People may trigger or intensify soil erosion, if they destroy vegetation that protects soils from wind and water (Olsson and Rapp 1991, 193; UNEP 1997, 26; Dregne 2002, 110, 122). Removing vegetation also decreases the amount of organic material that the soils receive from decomposing plant parts, which also decreases its production through decreased fertility (UNEP 1997, 26). People may contribute to desertification and land degradation with various practices such as cutting the vegetation too intensively, grazing large numbers of animals, or using too intensive agricultural methods (Graigner 1990, 65, 72, 95-105; Thomas and Middleton 1995, 67- 83). Henry le Houérou (le Houérou 1996, 146) believes that desertification occurs predominantly owing to human impact and claims that areas that are kept free from human and livestock interference seldom experience this problem. He acknowledges, however, that adverse climatic conditions such as droughts accelerate the phenomenon (le Houérou 1996, 146).

The UNCCD states that desertification is caused by various reasons and that desertification results *"from various factors including climatic variations and human activities*" (United Nations 1994, 4). The Convention notes that land degradation results: "*from land uses or from a process or combination of processes, including processes*

*arising from human activities and habitation patterns, such as: (i) Soil erosion caused by wind and/or water, (ii) deterioration of the physical, chemical and biological or economic properties of soil and (iii) long-term loss of natural vegetation* " (United Nations 1994, 5). Hence, the UNCCD 's description of the reasons behind land degradation acknowledges that both people and natural processes in the environment may contribute to the phenomenon, often affecting the environment together. This study also adopts the same idea.

### 1.3. Addressing land degradation with forestry-related rehabilitation

Land degradation is a problem that could be perhaps alleviated in many areas with protection and rehabilitation. In environmental discussions, the term rehabilitation refers to activities that are aimed to bring back elements or functions to an ecological system that has become degraded (McMahon 1997, 480). People may rehabilitate degraded ecosystems with various methods. Peter Ffoliott and others (Ffoliott et al. 1994, 328-348) have claimed that the most effective long-term methods to rehabilitate degraded land and to control surface erosion are based on establishing and maintaining vegetative cover. The vegetation cover protects the soil by reducing the impact of raindrops and the flow of water on the soil surface. Surface runoff is further reduced by plants, which reduce the quantity of the water stored in the soil between rainfall events. Soil erosion can be also reduced by the network of plant roots, and the increase in organic material can improve the quality and structure of a soil (Ffoliott et al. 1994, 328-348).

Rehabilitation with forestry activities consists of measures that are aimed at rehabilitating degraded land by creating and maintaining a vegetation cover, which includes the woody vegetation either exclusively or together with other plants. In dry regions, numerous methods exist to protect and rehabilitate degraded lands with the help of trees and shrubs. For example, people can plant trees and shrubs to protect their croplands against wind. People may also plant trees as intermixtures with agricultural crops to protect the crops from the effects of wind, solar radiation and rain. Moreover, scattered plantings in agricultural fields during fallow periods enrich the soil and provide wood and non-wood products. Further, people can plant trees and shrubs in order to produce firewood and other products that are used by them and by their animals. And finally, even areas threatened by sand dune encroachment can be protected with tree plantations (Ffoliott et al. 1994, 111-114, 308-339).

Rather than discussing rehabilitation with forestry activities, this study uses, however, an expression “forestry-related” in conjunction with environmental

rehabilitation programmes or interventions. The study understands "forestry-related environmental rehabilitation programmes" as types of development interventions that may use forestry activities to improve the environment, but they may also include other activities that may or may not be connected with trees such as activities to improve the productivity of croplands or to provide income generation activities for local people. The terminology chosen is a result of the development approach adopted in this study, which recognises that *rural development programmes have to be based on local priorities and local perceptions of the most critical needs* (see e.g. Chambers 1983; Chambers 2004). Moreover, it is acknowledged that environmental rehabilitation as such may not be perceived as the most critical development need in many dry areas.

### 1.4. Rural women as environmental managers in Sudan

Most of the Sudanese still earn their main livelihood from agriculture (World Bank 2003, 85). The rural women naturally interact with their environment in various ways, but their tasks in agriculture and firewood collection make their environmental impact particularly important. Farmer women carry out most agricultural tasks, although men commonly control cash crops. Nonetheless, droughts and declining incomes from agriculture have resulted in the migration of men in large numbers to urban centres, agricultural schemes and overseas (Ministry of Agriculture, Natural Resources and Animal Wealth 1995, 9-10) and while the men are absent from their villages, women have the responsibility for agricultural activities. A significant number of the households in Sudan are also female-headed (FAO 1998, 125-126). Women have also responsibilities for herding, feeding, milking, and processing of animal by-products (Farah 1990, 5). Hence, the rural women are important environmental managers in Sudan and therefore, this study assumes that their activities affect the environment also in the study area.

### 1.5. Aims and justification of the study

The purpose of this study was to increase understanding of local people's interaction with their environment in a certain, dry area of Sudan. The study focused on rural women in order to examine particularly their views and living circumstances. The study searched answers for two overall research questions, namely:

1. What kinds of roles have the local people, and the women in particular, had in the land degradation in the study area?

2. What kinds of issues would a gender-sensitive, forestry-related environmental rehabilitation intervention need to consider in the study area?

It was believed that in order to answer the two overall research questions, answers to several more specific research questions were required. The answer to the first overall research question of identifying the local women's roles in environmental changes was assumed to be found by finding answers to the following specific research questions:

1. How did the people studied perceive environmental changes in the study area and their own roles in these changes?
2. What kind of land degradation has occurred in the study area according to the outsiders of the study area?
3. What kinds of factors have affected the rural people's environmental literacy and their environmental activities in the study area?
4. What kinds of local livelihood activities have contributed to the land degradation and what kinds of roles the women have had in these activities?

The above-listed specific research questions also benefited the second overall research on issues that a gender-sensitive forestry-related programme would need to consider in the study area. Furthermore, three additional specific research questions were formulated, so as to provide information for the second overall research question, namely:

5. How did the people studied perceive the necessity for forestry-related rehabilitation in the study area and their own role in this rehabilitation?
6. What local trees did the people prefer most and how did they use them?
7. What are the constraints of and possibilities for local, and particularly women's participation, in forestry-related environmental interventions in the study area?

*These research questions guided the focus of this study, and the final, conclusion chapter in this research report summarises the answers to these questions*. The process of forming the research questions started prior to empirical research in the study area, but the collected empirical material was also used to further develop and specify the questions during the research process. Furthermore, previous theoretical discussions and studies of human/environment interaction in the study area and elsewhere had also an essential impact on how this study was conducted, since they supported the formulation of theory for this study. The adopted *theoretical framework* and the role of theory in this study will be described in the next chapter.

# 2. Theoretical framework

## 2.1. The main characteristics of the theory

Theory was as an important tool that supported this study from the beginning, affecting the formulation of research questions as well as the collection and analysis of the research material. As introduced in the previous chapter, the study topic was about environmental changes and people's roles in these changes, focusing on a certain area in Sudan. In the study area, the research thus covered the biophysical environment and the people, their thinking and behaviour. Since both the social context and the biophysical environment were under study, the theory had to provide tools to analyse both of them. Hence, the theoretical framework had to be able to conceptualise both the social context and the biophysical environment appropriately for this study.

The designed framework was based on an argument that biophysical and social environments are complex and varying from one area to another. Emphasising the social and biophysical complexity of different areas might at first seem self-evident, since this complexity is widely acknowledged. However, when human environmental behaviour has been explained and theorised in the past, a number of discussions and studies has concentrated on certain particular factors that have been believed to largely explain why people have conducted certain environmental practices. While concentrating on these factors, other issues have been given less or even no attention. In this chapter, some of these discussions will be introduced and it will be explained how their ideas have been adopted in this research. As a whole, the chapter introduces a variety of previous approaches and studies, explaining how each of them has affected the theory of this thesis. This way, the theoretical approach is gradually constructed and at the end of the chapter, summarised in a figure format.

## 2.2. The social context

### 2.2.1. How politics in the social context affects environmental behaviour

The construction of the theoretical framework begins with an analysis of the approach of this study to the social world or social context in different areas. In this study, the social context is understood to refer to all life in human groups, which includes cultural, economical and political aspects. Although presented separately, these elements are not understood as separate entities; rather, they are intertwined

and tend to affect human environmental behaviour together. These parts in the social context have also a dual character: on the one hand they are concretely present in the material world in such areas as the distribution of economic assets; on the other hand they are created and modified by human thinking and behaviour.

The present study understands the term politics as practices and mechanisms in which people negotiate and exercise power. Power, in turn, is perceived as social relation that is built on the asymmetrical distribution of resources and risks between people (Hornborg 2001, 1; Paulson et al. 2003, 205). Empirical studies suggest that humans may exercise power over others in various ways that affect the management of the biophysical environment. This has occurred in a rural community of Morocco, where ethnically-based power relations had determined the roles various people have had in land use decisions and in agricultural practices (Ilahiane 1996, 89-90).

Exercising power from outside the actual area may also affect local environmental management practices. In an area in western Mali, local environmental management has been affected by government activities including involuntary settlement (Koenig and Diarra 1998, 34). Politics or the exercise of power can also be connected to development projects. In an area in northern Guatemala, government institutions and development workers have pressured rural people to change their agricultural practices. Many locals have not been, however, convinced that the imposed activities would really provide more benefits than their traditional practices. As a result, the local people have commonly changed some of their farming activities during the time they have been assessed by the outsiders, but stopped the new practices once they were no longer monitored (Siebers 2004, 42).

It has also been highlighted that power may be exercised to affect the dominant environmental images and conceptions over a certain area. In an area in Nicaragua the government has emphasised the need to conserve the ecologically valuable area by protecting it from use by local residents. Simultaneously, local people have resented the idea of preserving large areas of wilderness. They have pointed out that protection of the rainforest from agricultural and other uses has no future if local requirements for livelihood are not addressed (Nygren 2004, 195-200).

This study concurs that use of power often affects how different environments are perceived, managed and discussed. At the same time, this study stresses that the impact on power to human environmental behaviour needs to be studied separately in different areas, before assumptions and conclusions can be made about the effect of politics on environmental behaviour. In theoretical discussions, the impact of politics on environmental practices has been particularly analysed within the discussions in the *political ecology* approach.

Political ecology was originally developed to support research on ecological crises, linking together social and natural sciences (Paulson et al. 2003, 206). Its roots are in the 1970s, but it started to gain more popularity during the 1980s and the 1990s. Raymond Bryant and Sinéad Bailey (Bryant and Bailey 1997, xi, 10-15). describe political ecology as a diverse approach, including various ideas of the factors that are seen to affect human environment interaction, but they also maintain that the idea of a "politicised environment" is part of the political ecology approach, which believes that environmental problems cannot be understood in isolation from the political and economic contexts within which they are created.

Susan Paulson and others (Paulson et al. 2003, 205-206) have claimed that although the political ecology approach has been diverse, its conceptualisations have often included certain ideas such as the one that people tend to have a plurality of positions, perceptions, interests and rationalities in relation to the environment. According to them, it has also been assumed that the pressure of production resources (such as natural resources) is transmitted through social relations and it is actually these relations that have resulted in excessive demands on the environment. Further, the concept of marginality (that may be connected to politics, economics and ecology) has been used in political ecology discussions (Paulson et al. 2003, 205-206).

The theory of this study not only consents to the idea that exercising power may affect environmental practices, but also to the notion that people may have a plurality of positions towards their environments. The issue of marginality is also acknowledged, although the theory here assumes that generalising marginality as the main cause of environmental degradation in all places is a problematic view since empirical studies suggest that poverty does not always cause environmental degradation.

Poverty has affected land management practices in an area in Rwanda, where particularly wealthy farmers have been able to invest economically in land conservation and soil fertility (Clay et al. 1998, 373). Simultaneously, a survey from a rural area in Peru revealed that the state of natural resources was mostly connected with management activities. There particularly poorer farmers have managed the agricultural land in a sustainable manner while wealthier farmers have bought large herds that have contributed to environmental degradation. The only clear link between poverty and harmful environmental practices was found in fuelwood cutting by the poorest households, who could not afford to buy other fuel for their cooking and heating (Swinton and Quiroz 2003, 1903, 1917).

Similarly, in an area in Niger the generally wealthier farmer households have been able to diversify their livelihood sources, but they have paid less attention to their croplands. This has caused more erosion in the croplands of the wealthier rather than poorer households, whose survival depended solely on their croplands (Warren et al. 2001, 89). Hence, the empirical studies suggest that the impact of poverty (and wealth) on environmental practices needs to be studied separately in different contexts, before conclusions are made about the poverty's link to environmental degradation. This study also adopts the same view.

Most significantly, the theoretical framework of this study is, however, influenced by the ideas that Piers Blaikie and Harold Brookfield presented already in the 1980s. Piers Blaikie, who discussed the human role particularly in soil erosion, perceived rural people as land users who made decisions on how natural resources were used (Blaikie 1985, 108-109). He also presented a model that described how land use decisions contributed to soil erosion, stressing particularly the importance of income opportunities as a factor that influenced the land use decisions.

Later, Blaikie and Brookfield theorised the role of humans particularly in land degradation, presenting rural people again as decision-makers. This time, they emphasised that land degradation occurs as a consequence of *various interacting social and ecological factors that affect land users 'decision-making and consequent environmental practices* (Blaikie and Brookfield 1987, 70). Although they assumed that land users are often part of the land degradation phenomenon, they also recognised that environmental processes may occur without human interference. At the same time, they viewed land degradation as something highly related to human behaviour, believing that "land degradation should be by definition a social problem" since the term "degradation" is a socially- constructed label or criterion given to a land by people (Blaikie and Brookfield 1987, 1).

This study adopts also the idea of people as actors who make decisions on their environmental and other behaviour. This idea has been also presented in anthropological discussions. Anthropologists have explored people's relationships with their environments for approximately 100 years within a research tradition often referred as *ecological anthropology*. In the beginning, anthropologists believed that features of human society and culture could be explained in terms of the biophysical environments in which they have developed. This idea, known as environmental determinism, lost its dominance later on, when anthropological studies proved that communities with differing social structures and institutions lived in rather similar biophysical environments. Consequently, anthropologists generally only recognised that the biophysical environment sets the limits on cultural development, dictating what is possible to do in certain natural conditions

(e.g. the climate affects the selection of crops). They called this approach possibilism (Milton 1997, 477-478).

Later, anthropologists started to critique possibilism for two reasons. First, studies that used possibilism as an explanatory framework seemed to provide rather limited amount of ethnographic information such as details of people's economic and political strategies and of their ideologies. Second, it was stressed that the biophysical environment should not be perceived solely as something negative that limits cultural evolution. The new approach that was introduced, called cultural ecology, was based on an assumption that specific environmental factors shape particular cultural features and that cultures are capable of successfully adapting to various biophysical environments (Milton 1997, 478).

In the 1960s and 1970s, cultural ecology lost its popularity. Empirical studies suggested that the idea of cultural features successfully adapting to environmental conditions did not always occur in practice (for instance, a study disclosed that inhabitants of an island in South-East Pacific had endangered their survival by using up their timber resources for ritualistic purposes). Two directions became now popular in ecological anthropology. One of them applied the ecosystem approach or model that perceived people as integral parts of their biophysical environments in a *system that included material exchanges.* The studies explored how an ecosystem operates, working out how the material exchanges among its participants balanced out. This required anthropologists to measure and compare such things as the impact of soil fertility on different modes of cultivation. In focusing on the material consequences of human activities, the ecosystem approach paid less attention to people's own cultural understandings of the world (Milton 1997, 483).

Nevertheless, since the 1960s, numerous anthropologists had became also increasingly interested in understanding *people's own perceptions and interpretations of the world*. These anthropologists were more interested in what generates people's behaviour (their goals, motivations, assumptions, beliefs) and in the social and cultural consequences of their actions, than the ecological impacts of their behaviour. The interest to explore people's own conceptual models resulted a research field known as cognitive anthropology (Milton 1997, 484).

The biologically oriented research field that studies environmental conceptions of a particular ethnic or cultural group, known as ethnoscience (Meehan 1980, 379), can be classified as one of the sub-fields of cognitive anthropology (Milton 1997, 484). Ethnoscience, in turn, has included a number of subfields such as ethnomedicine, ethnobotany and ethnopedology that concentrates on people's knowledge of soils (see Barrera-Bassols and Zinck 2003b). The terms used in ethnoscience have been

followed by a number of other terms, which have been used to describe people's conceptions of the environment. These terms will be discussed later in this chapter in conjunction with introducing one of the key terms used in this study, namely *environmental literacy*.

The political ecology approach that emerged in the 1970s, was critical towards ethnoscience and other types of social scientific environmental research that discussed people's environmental conceptions and relations with the environment without considering impacts of power and its use. Political ecology confronted particularly the ideas of cultural ecology, which had presented communities as if they would live in harmony with their biophysical environment, isolated from the impact of global markets and social inequalities. The development of the approach was influenced by peasant studies and critiques of colonialism as well as by the growth of the influence of Marxism within social sciences. The overall shift in the social scientific paradigm from an equilibrium to a nonequilibrium stance also challenged the earlier ecosystem model, which had focused on adaptation, self-regulation and achieving balance (Paulson et al. 2003, 207). Hence, political ecology provided alternative perspectives to human ecology[1] (see Little 2003, 4).

Political ecology has been, and still is, influential particularly in anthropology and geography. But although political ecology has been applied in numerous studies, it has also been criticised. Andrew Vayda and Bradley Walters have claimed that political ecology studies generally lack adequate ecological analysis and include a priori judgements believing that social relations and politics are central factors causing environmental changes and problems. They have suggested that political ecology be replaced with an approach which they suggest to be named as "evenemental" or "event ecology". The suggested approach focuses on specific environmental changes or events that a researcher wants to explain. The preferred method is first to examine specific environmental changes as such and after, to study the past in order to construct chains of causes and effects leading to the environmental changes (Vayda and Walters 1999, 167-169).

Vayda's and Walters's critique seems not completely justified, for at least some political ecology studies have included historical analysis covering both social and ecological developments over time in certain areas (Kull 1998; Koenig and Diarra 1998). Furthermore, studying the past as they suggest has similarities with the whole

[1] Human ecology, a term that has been understood in numerous ways and which has its own history also in sociology and geography, has been normally understood in anthropological discussions as studies on the relationship between culture and environment, including the cultural ecology and ecosystem approaches

research field of environmental history. Donald Worster (1988, 290-291) has described environmental history to include the goals of deepening understanding of how humans have been affected by their biophysical environment and how they have affected that environment. In brief, environmental history has been described as an attempt to elucidate the interaction between humans and nature in the past (Myllyntaus and Saikku 2001, 2). In addition, the environmental history of Africa has had its own, specific characteristics; the approaches have been generally rather critical towards western science, and it has been typical to highlight the value of the local people's knowledge of their environment (Beinart 2000, 275-277).

The influential idea for this study, also stressed by Vayda and Walters, is that studies of human-environment interaction need to include adequate biological, scientific knowledge of each area (Vayda and Walters 1999, 170). Thus, the theory acknowledges that scientifically-based ecological analysis benefits any research on human-environment interaction, including also the present study. Nonetheless, it is also stressed that environmental terms such as land degradation are socially-constructed; people have themselves designed these terms to describe processes in the biophysical environment. Later, the chapter of the study area (chapter 4), discusses further the complexities and problems of the concepts of desertification and land degradation. Nonetheless, most importantly, it is believed that *local people's perceptions of their environment and their lives* in different areas are crucially important, when human interaction with the biophysical environment is explained and analysed in different contexts.

### 2.2.2. The nature of the economic context

Hence, it is emphasised that both biophysical and social contexts need to be studied in different areas to gain understanding of the human environment interactions that relate to environmental changes. In addition to politics, the social context includes cultural and economic life. Karl Polanyi, who stressed the connection between economic life and culture, has influenced the manner in which the present study understands the economic life. According to him (Polanyi 2001, 31) economic life in human societies may be perceived to have two meanings. Firstly, it has a "substantive meaning", which refers to the fact that a person depends upon nature and other people. As a result of interchange with a person's natural and social environment, a person is supplied with certain means that can be used to fulfil her/his material needs. Emphasising economic life as part of the overall social world has been a typical approach in sociology of economics (Smelger and Svedberg 1994, 4), but Polanyi also associates "formal meaning" with economic life. This refers to a

particular situation, where a person makes a choice about using available means to obtain desired material consequences (Polanyi 2001, 31).

Following these ideas, people's economic decision-making is perceived here as an important factor that affects their environmental behaviour, acknowledging at the same time that this decision-making is strongly affected by the social and biophysical contexts people live in. Economic circumstances at a local level tend to be also connected to state and global-level policies and economic systems. For instance, families in the farmer village of this study produced commonly gum arabic, a gum that is obtained from *Acacia senegal* (L.) Willd. trees, which they grew on their agricultural land. The price that they had received from the gum sold to merchants had been affected by multiple factors such as the government policies of the minimum price that the merchants had been required to pay for the gum. The government, in turn, had controlled the export of gum arabic (El-Dukheri 1997, 43-44) and had been thus affected by the global gum arabic markets (more about the Sudanese gum arabic trade in chapter 6.4.4).

### 2.2.3. Rural economic context: land tenure systems and property rights

Rural communities require land for their livelihood and therefore, need first of all *access* to land. This access tends to be socially determined – it depends on other people whether and under what terms a person or a group of people can use a certain area. Politics tend to be part of the land allocation processes; for instance, traditional leaders may exercise decision-making power over land allocation (e.g., Kevane 1997, 298-300).

Concepts of property rights and land tenure arise often in discussions on land use. In this study, the term property right is understood to describe a right that authorises individual or group use of natural resources, simultaneously implying that others respect that right. It is hence assumed that a property right may include different types of authorised activities: use of all natural resources in a certain area or only part of them, such as trees (Rocheleau and Edmunds 1997, 1360; Fernández-Giménez 2002, 51). Land tenure is, in turn, understood to refer to either a legally or customarily defined *relationship* among individuals or groups of people with land and associated natural resources. Rules of tenure define how property rights to land are to be allocated in societies. Land tenure systems determine who can use what resources, for how long and under what conditions (Ciparisse 2003, 36).

In tropical farming communities, particularly the arable land is crucial in order to sustain a livelihood. Agricultural land may be acquired through inheritance, renting

or buying (see Kevane 1997, 298-300; Clay et al. 1998, 373). An important factor that naturally affects the quality and quantity of bought and rented land is people's access to financial resources. These resources may also affect how land is used; when choosing what to cultivate and how to cultivate, farmers often prioritise such crops they believe would provide them the highest economic benefits. Nevertheless, although rural households generally need to consider economic aspects in order to make their livelihood, explaining environmental behaviour as an activity that is solely based on economic considerations tends to simplify complex realities. In various contexts, other factors such as culture and politics also tend to play a role in humans interaction with their environment.

William Grisby has claimed that in Africa women's customary property rights generally exist through their identities as daughters, sisters or wives. The women are more likely than men to be landless, and to have fewer rights or land use types than men (Grisby 2004, 207). Dianne Rocheleau and David Edmunds have used the term "gendered space" to describe an area that is rather independently managed by either men or women ,including women's own croplands in some areas. With particular reference to Africa, they claim that trees used by women are often in such areas that are controlled by men in customary land tenure regimes and that in general, *men often regulate women's use of natural resources*. They nevertheless recognise that women's access to and control over natural resources may vary significantly over time depending on changes in social and ecological factors in an area and the manner in which the changes are negotiated between women and men (Rocheleau and Edmunds 1997, 1360-1361).

Based on empirical studies in India, Bina Agarwal has concluded that in rural households and at community and state levels women and men tend to bargain power over fulfilling their subsistence needs such as that for food. She believes that the most important factor strengthening women's bargaining power in relation to subsistence needs is *ownership of and control over assets, particularly arable land.* Other factors include: access to employment and other income-earning means, access to communal resources such as village commons and forests, access to traditional social support systems (patronage, kinship etc.), support from NGOs, support from the State, social perceptions and social norms (Agarwal 1997a, 8-9, 35). In this study, it was also assumed that men tend to exercise power over women concerning the rights to use natural resources, but it was also believed that these rights may be changed over time. It is possible that women negotiate and bargain for these rights (Rocheleau and Edmunds 1997, 1354), and also societal phenomena such as male migration may affect women's land tenure (see Myers et al. 1995, 16).

Sources of livelihood nomadic pastoralists' may or may not include cultivated land. They nevertheless need for they livelihood such lands that they can use for their animals jointly with other people. In previous discussions, this type of land has been described with specific terms such as common-pool resources (Ostrom 1990; Steins and Edwards 1999) and common property resources (Hardin 1968; Ciparisse 2003, 7). Both terms are currently used, but since the term common property resources is an older concept and therefore perhaps still more widely known, it is also adopted in this study. In brief, common property resources refer to such natural resources, which are used jointly by people, but which are not owned by them. Moreover, it is recognised that the use of common property resources is often affected by traditional property rights and the systems and institutions to control these rights (Ostrom 1990, 2; Ciparisse 2003, 7).

The term common property resources was introduced by Garret Hardin (1968) in his influential article with the topic "tragedy of commons". He discussed particularly pastoral communities and believed that overexploitation of common property resources occurs due to an individual user's aim to maximise benefits the user can extract from jointly used common property resources. To solve this problem of individuals exploiting the common property resources, he suggested privatisation and government control. Thus, Hardin did not believe that local governance institutions could address the issue of degrading natural resources in commonly-used areas (see Hardin 1968, 1246-1248).

Later, it has been claimed that the theory of "the tragedy of commons" and the suggested solution of privatisation are actually quite problematic ideas and that, for example in Africa, privatisation has actually worsened many problems such as land degradation (Niamir-Fueller 2000, 255). Also, an ecological study conducted in eastern Namibia found no significant differences in the state of the environment in a communal farming area compared to the commercial farming area in the same region, suggesting that Hardin's ideas are not universally applicable (Ward et al. 1998, 367-369). Therefore, the theory of this study views the governance of common property resources as a complex issue that is affected by multiple factors and stresses that conclusions concerning environmental changes in communally-used areas should be based on adequate knowledge of each particular context.

Nathalie Steins and Victoria Edwards have suggested that the outcome of collective management is the result of interaction between stakeholders and the biophysical environment, which depends on how social actors construct their everyday reality. Consequently, it should be understood *how social reality motivates* people to perform certain action strategies in certain biophysical environments. People tend to consider whether it is more beneficial to invest time and efforts to collective action or

alternative activities to gain social and economic benefits. After the benefits and costs of different activities are considered, people act maximising their benefits (Steins and Edwards 1999, 539, 551).

Although Steins and Edwards have acknowledged that people's decisions on how to manage common property resources have been affected by their social and biophysical contexts, they also assume that individuals weigh different options available to them and then act to maximise their social and economical benefits. To a certain extent, this study agrees with this position; it is assumed that *people in many cases ponder the consequences of their different choices and then perform such activities that gain as many benefits as possible.* All in all, human environmental behaviour is, nonetheless, seen as more complicated matter by nature and it is assumed that the behaviour cannot be always automatically reduced to an individual's rational decision-making. For instance, different ethnic groups may perform different agricultural activities in the same area (Reenberg and Paarup-Laursen 1997, 225).

Therefore, to conclude, it is claimed that economic considerations do not solely determine how people manage their environment – although they are likely to be important due to livelihood needs. Furthermore, this study views economic life as an integral part of the social world and therefore, it is believed that even when economic considerations affect environmental behaviour, other elements in a social context tend to simultaneously contribute to the behaviour. Previously, the impact of politics to environmental practices was theorised. Next, the issue of culture in connection with environmental activities will be discussed.

### 2.2.4. Cultural perceptions of the environment

Culture in the social context refers in this study to everything that in a human society is transferred socially referring to *learned and symbolic aspects of a society* (Marshall 1998, 137). These learned ideas are believed to have an important impact on people's thinking and their relationship with the biophysical environment. The following, commonly-known idea is acknowledged: "If we take several people looking at a wooded hillside, they all see the same natural landscape but they may perceive it, know and think about it, entirely differently according to their culturally conditioned understanding" (Sillitoe 1998, 206).

Learned ideas of the biophysical environment have an important impact on land use practices in rural communities. Cultural conceptions may include a variety of perceptions. The conceptions may be "practical" by nature, including, for instance, knowledge of the properties of soils and suitable management practices (Bocco 1991,

347-348; Barrera-Bassols and Zink 2003, 232-243). Cultural conceptions of environment may be also more "abstract" by nature, including cosmological ideas such as conceptions of ancestors as guardians of certain natural resources (Ossewejer 2000, 68).

Manon Osseweijer has referred to the former type of cultural knowledge of the environment as practical and the latter as metaphysical knowledge, recognising that they are likely to be interconnected and mutually influential (Osseweijer 2000, 55). In this study, particularly *religious* conceptions deriving for example from Islam or Christianity are viewed as factors that may affect environmental perceptions as metaphysical knowledge. In connection with the research on environmental changes, it is assumed that religion may affect, together with various other factors, how people perceive their options and power to address environmental changes such as deforestation or land degradation.

### 2.2.5. The effect of gender on environmental activities

The theory of this study assumes that a particular set of cultural perceptions that affect environmental perceptions and environmental behaviour in different areas is *gender.* The term gender has been described in numerous ways (see e.g. Kramarae and Treichler 1985, 173-174; Østergaard 1992, 6; Humm 1990, 84-85; Marshall 1998, 250; Eriksen 2001, 125; INSTRAW 2004). Although descriptions of the term gender vary, they generally include one central idea: human societies are affected by socially constructed ideas of how women and men are like and particularly, how they differ from each other. Briefly, the term gender thus refers to socially constructed sex rather than biological sex. It is hence defined here as *socially constructed and learned ideas of how men and women are like and how they differ from each other*.

Gender tends to contribute to environmental management practices, for shared views on what women and men are like and what kind of behaviour is appropriate for them, affect which activities members in both groups are expected to perform. Gender also affects the lives of women and men through politics and economic life, since gender ideology that includes assumptions about men's and women's capabilities and appropriate roles, affects who have decision power and control over natural resources (see Agarwal 1997a, 1-3, 8-10; Grisby 2004, 207).

Bina Agarwal (Agarwal 1997b, 31-37) has discussed gender particularly in relation to women's role in collective action, focusing on community-based initiatives in India that were introduced to protect forests and to plant trees. Based on these initiatives

she has found several factors that have encouraged and facilitated women's involvement in collective management actions. A major factor that has facilitated women's participation in common meetings has been the presence of a gender-progressive non-governmental organisation (NGO). Experiences from several areas in India also suggest that if women are involved from the beginning in organising collective management, the chances of their sustained participation is greater. Gender-sensitive forest officials and a large number of participating local women have also encouraged women's active and vocal participation.

These factors address, nonetheless, mainly the cultural barriers to women's participation, the gender ideology of what is considered acceptable female behaviour. Rural women's material conditions such as heavy work load (childcare, housework, agricultural activities) have still remained as a constraint on women's environmental action initiatives in many rural communities. Nevertheless, since women in several regions of India have formed their own informal associations to protect forests, Agarwal believes that the rural women's constraints against participation of the joint efforts to protect commonly-used forests are not insurmountable challenges (Agarwal 1997b, 38-39).

However, although gender commonly affects how men and women manage their environment in rural areas, gender cannot be generalised as a factor that determines exclusively women's and men's behaviour and relationships with their environment (see Braidotti et al. 1994, 8). In fact, it needs to be recognised that groups of women and men are likely to include individuals who have various kinds of relationships with their environment (Jackson 1993, 405-418; Sturgeon 1999, 262-264).

It can be noted here that these assumptions disagree with the views of Vandana Shiva, perhaps the most famous ecofeminist of all. Shiva believes that southern, rural women have a tendency to protect and take care of the environment, while men tend to protect less the environment and are largely responsible for environmental destruction (Shiva 1989, 42). Since Shiva perceives women protective towards the environment just because they are women, she also seems to assume that women's biological characteristics (she seems to perceive women as nurturing mothers who want to protect all living) play central roles affecting their environmental behaviour. The theory of this study disagrees with such generalisations and emphasises that the study cannot be based on predetermined ideas of how women and men perceive their biophysical environment. Rather, the theory assumes that by studying local women's and men's environmental conceptions and practices in different contexts, it is possible to explore how gender has affected their relationships with the environment.

Furthermore, this study is development-oriented, since one of the main aims was to formulate suggestions for gender-sensitive, forest-related environmental rehabilitation programmes in the area studied (see chapter 1.5). From gender-related development discussions, the study has adopted particularly ideas from an approach known as GAD (gender and development), which has since the 1980's become widely adopted in the mainstream international development co-operation and related research, following the earlier WID (Women in Development) approach.

Development researchers and professionals developed the WID approach in the 1970s as a response to international co-operation policies that had perceived women mainly as mothers and reproducers (Braidotti et al. 1994, 78-83). Formulation of the WID was influenced particularly by Ester Boserup's book "Women's Role in Economic Development", published in 1970. In the book, Boserup claimed that economists and developers had ignored women's labour input in agriculture and other productive activities. She also raised the view that modern agricultural technology, introduced solely to men in development programmes, had in fact produced harmful consequences to women (Kirjavainen and Pehu 1988, 340; Braidotti et al. 1994, 78; Razavi and Miller 1995, 3). The early WID stressed that southern women are important economic actors (particularly as agricultural producers) and demanded equity for women and men. In the mainstream development co-operation the equity demand was, however, later largely replaced by a view that only demanded women's equal rights to participate in poverty reduction and economic development programmes (Braidotti et al. 1994, 78-80).

By the late 1970s, some developers had already started to critique WID policy, claiming that it did not approach the social context profoundly enough. WID believed that women's lack of access to resources was the key issue to tackle and did not analyse further why women's access to resources had been restricted in the first place. At the same time, the work that was under way within various social scientific discussions and studies raised the importance of power, conflict and gender relations in understanding women's subordination (Razavi and Miller 1995, 12).

By introducing and adopting the GAD approach since the late 1980s, international development community adopted the gender concept from social sciences and started also look for the potential in development initiatives to enhance equality and to empower women (Braidotti et al. 1994, 82). *GAD emphasises that gender relations affect all aspects of women's lives* and that a gender perspective, which pays attention to the impact of gender to women and men, should be mainstreamed in all development policies (Braidotti et al. 1994, 82; INSTRAW 2004). Moreover, since GAD emphasises the need to understand how gender affects the people in different contexts, studies that apply its perspectives seek knowledge of social context at

large, not solely about women. Consequently, in order to collect multi-faceted information of various contexts for development purposes, specific GAD-related research approaches and methods have been designed for such as gender analysis (see e.g. Rao et al. 1991) and approach in SEAGA (Socio-economic and Gender Analysis Programme) (FAO 2006).

Although this study does not apply research methods often used in GAD-related research, it has been affected by GAD. Similarly with GAD, the theory emphasises here the need to acquire multi-faceted knowledge of social (and biophysical) context, including knowledge on how gender has affected women and their relationship with the environment. GAD's development goal of equality between women and men is also acknowledged, but this study also recognises that women are likely to have variable positions and situations in their families and communities as well as to come from families with variable socio-economic statuses. For instance, in areas that are used both by farmers and nomadic pastoralists, relatively wealthy women farmers may found themselves in less vulnerable positions compared to men in poor nomadic pastoralist families.

As a whole, the theory emphasises that *in order to understand how gender has affected women's environmental interaction in different contexts, thorough understanding of their social and biophysical environments is needed.* It is believed that in order to achieve such understanding, it is beneficial to include both women and men in the studies, even when the main focus of the study is on women. The theory stresses that gender plays a significant role affecting women's lives and their environmental interaction, although at the same time also various other factors affect people's environmental practices and their environmental impact. One of such factors is population growth.

## 2.3. The impact of population growth on environmental changes

Paul and Anne Ehrlich (Ehrlich and Ehrlich 1990, 127) have claimed that population growth is generally one of the main causes of desertification. The degrading effect of population growth to a biophysical environment is nonetheless a complicated matter, since people may adapt to changing social and ecological circumstances by developing their agriculture or diversifying their practices of earning livelihood (see Mortimore and Adams 2001, 55).

UNCCD acknowledges that population growth is one of the factors that had made it more difficult for local people to implement successful strategies to adapt to changing circumstances such as droughts (UNCCD 2004). This view is also adopted in here. It is, however, also assumed that population growth does not automatically

result in environmental degradation. People live in complex social and biophysical environments where the impacts of population growth on biophysical environments vary. Hence, population growth is here seen as one possible factor that may cause or intensify environmental degradation, but not always nor with similar significance in various areas. It is hence emphasised that also the role of population growth needs to be analysed separately in different areas.

## 2.4. The biophysical context conceptualised

In scientific research, the biophysical environment has been studied in various ways. Environmental studies within the natural sciences have traditionally approached the environment and its parts with standardised concepts and methods that have been developed by the research community within scientific discourse (see e.g., Bekunda et al. 1997; Koskela et al. 1999). However, as described in Chapter 1.1, the biophysical environment has been also described and analysed with local people's conceptions (Bollig and Schulte 1999; Osseweijer 2000). To add, local perceptions of the biophysical environments have also been compared to scientists' and other "outsiders'" conceptions of the same environments (Fairhead and Leach 1996; Lane 1997; Lykke et al. 1998; Gray and Morant 2003).

In this study, local and outsiders' views on the same environment are also analysed and compared. The approach is based on a recognition that a biophysical environment may be perceived and analysed in various ways and that combining different conceptions is likely to increase our understanding of an environment and the changes that had occurred there. Similar to the view of the anthropologist Paul Little (Little 1999, 258), the theory of this study recognises that the studies that direct their main focus on local people's perception, benefit also from natural scientific knowledge. Although a biophysical environment is something that is perceived and explained by people, it is simultaneously also something that forms its own material entity. Often people interfere with and affect the biophysical environment, but whether they do so or not the biophysical environment still exists – regardless of people. It seems therefore beneficial to study and analyse the biophysical environment using various conceptualisations and sources of information.

In this study, the biophysical environment is understood to consist of different material parts (climate, soil and vegetation) that interact. The slightly more specific manner that the structure of the biophysical environment is conceptualised, is affected by Robert Bailey's book called "Ecosystem geography" (Bailey 1995). The widely-used concept of ecosystem was actually introduced already in the 1930s (Bailey 1995, 5; Stilling 2002, 336), but Bailey uses the term in a way that provides an

appropriate perspective for this study. The underlying idea is that the earth includes a series of ecosystems. An ecosystem describes an area where a change in any component will bring about a change in other components and the operation of the whole system. The ecosystems include both biotic (such as plants and animals) and abiotic (such as rocks and air) between which the different components of energy and materials flow. The various ecosystems of the Earth reside within each other and remain open to transfer of energy and materials from other ecosystems (Bailey 1995, 3-14).

Ecosystems can be described with various levels of detail, disclosing different amounts of information about a certain biophysical environment. To describe more in detail a biophysical environment of a rather limited area Bailey uses the terms site (or, microecosystem) and *landscape* (or, mesoecosystem). The term site describes a specific area of a few hectares. Linked sites can be understood to create a landscape that "seen from above looks like patchwork". A landscape is thus perceived to include spatially contiguous sites distinguished by material and energy exchange between them. A landscape can vary in size from 10 $km^2$ to several thousand square kilometres. From a spatial perspective, the ecosystems are perceived to vary and interact with each others both vertically and horizontally, affected by topography (Bailey 1995, 23, 25).

This study perceives the term landscape (that is commonly used particularly in geography) as useful for describing the biophysical environment of the study area. But most of all, recognising that changes in any part of an ecosystem may affect other parts of it (and in ecosystems linked to it) is seen as an important idea in connection with the land degradation phenomenon. Whether affected by humans or not, land degradation can be understood, in the ecological sense, to refer to a situation where changes in an ecosystem (or, ecosystems), its components and processes have occurred, resulting in reduced land productivity.

In sum, it is highlighted that the theory asserts that both cognitive and material dimensions are often connected to the biophysical environment. Regardless of human perceptions of it, the biophysical environment is there, although people perceive and explain these environments in various ways. Natural scientific research is one way to approach the environment and it is beneficial when different environments and their changes are studied, regardless of the main topic of research. Hence, the biophysical environment was here conceptualised with some commonly-known terms from ecology and geography. Moreover, available natural scientific information is used in the study to acquire as much understanding as possible of the environment studied.

Mostly, it is stressed, however, that when environmental changes, and particularly, people's roles in such changes are analysed, local people's perceptions need to be included. It is assumed that the manner that rural people perceive their ecological and social environments affects their environmental practices and identifying their thinking will help to understand the social and biophysical circumstances that have contributed to the environmental changes.

## 2.5. The concept of environmental literacy

This study believes that environmental literacy, i.e. conceptions of one's biophysical environment (Hares et al. 2006, 129), affects how people interact with their environment. As described previously in this chapter (sub-chapter 2.2.1.), particularly anthropological research has included studies on people's conceptions and knowledge of their environment. Anthropologists (and also researchers representing other disciplines such as geography and ecology) have used a number of terms to describe rural people's knowledge of their biophysical environment. These terms have included, for instance, traditional knowledge, local knowledge, indigenous knowledge and traditional ecological knowledge (Bocco 1991; Sillitoe 1998; Dove 2000; Berkes et al. 2000).

Particularly anthropologists have discussed to which type and whose knowledge these terms actually refer. Conventionally, this type of knowledge has been often viewed as cultural knowledge that is learned from other local people, which has been perceived as something that differs from scientific knowledge having its own specific characteristics (Ellen and Harris 2000, 4-5; Martin 2003, 5). Also, it has been pointed out that in connection with development efforts, local and scientific knowledge should not be presented in epistemological opposition, but should be seen as completing each other to benefit local people (Agrawal 1995, 433).

Furthermore, it has been demonstrated and analysed with empirical examples that local environmental knowledge may in fact include a mixture of various elements, including traditional cultural knowledge transferred from one generation to the next and, on the other hand, other elements such as knowledge received from development organisations (Martin 2003, 68 ). Local knowledge has been described to emerge from context-specific realities in which cultural, environmental, economic and socio-political factors intersect (Nygren 1999, 282).

In this study, the term environmental literacy is viewed in a similar manner. Moreover, although it is stressed that environmental literacy is greatly affected by the social and biophysical contexts in which people live, it is also acknowledged that

personal attributes such as intelligence and personal interests affect literacy. Environmental literacy is also dynamic by nature, as interaction with the biophysical and social contexts affects literacy continuously. Hence, this literacy is not only a cognitive entity that affects human environmental behaviour, but something that is constantly modified by human behaviour when people interact with each other and with their biophysical environment (Hares et al. 2006, 129).

Environmental literacy is also perceived as something that everyone possesses, not only local people to a certain area. Moreover, no a priori assumptions or criteria are set for its content. It is perceived as a concept that simply refers to people's conceptions of the biophysical environment, which both outsiders and local people may possess (Hares et al. 2006, 132). As presented in chapter 1.1, this study aims to combine local people's and outsiders' environmental literacy of the study area. This is, however, acknowledged as a complex task, for conflicting and different perceptions may appear. For instance, as brought up earlier in this chapter, local people may view the need for environmental protection in different ways compared to the outsiders' perceptions (Nygren 2004, 195-200) or they may disagree with the management practices the outsiders see as environmentally appropriate and sustainable (Siebers 2004, 42). Studies also suggest that local people may perceive the severity or reasons behind their cropland degradation differently, compared to outsiders' studies and views (Kiome and Stocking 1995, Gray and Morant 2004).

However, it needs to be brought up that the concept of environmental literacy has been used previously rather differently than it is used in this study. Hsu and Roth date the origin of the term environmental literacy to the end of the 1960s and since then, it has been particularly used in discussions on environmental education and responsible environmental behaviour. In these discussions its reference point has been scientific knowledge to which environmental literacy has been equalled (Hsu and Roth 1998, 233-234).Traditionally, environmental literacy has been viewed as a term that refers to the ideal, sustainable and "correct" knowledge of the environment (see David 1974; Brennan 1994; King 2000) that has been also called "ecological literacy" by David Orr (Orr 1992).

The approach here is different, for it is assumed that environmental literacy may include various types of conceptions. Moreover, it is believed that this literacy varies at the individual level, although groups often share common knowledge that has been transferred when people have interacted with each other (Hares et al. 2006, 129). Environmental literacy may result in sustainable environmental management practices; based on many empirical studies, it is now widely recognised that rural communities in the tropics often possess detailed literacy of their environment as well as innovative skills and systems to manage natural resources (Warren and

Pinkston 2000, 158-159). Nonetheless, even in these rural communities people may also possess the kind of environmental literacy that leads to unsustainable environmental behaviour (Doolittle 2003, 247). Further, even if people do possess such environmental literacy that would enable sustainable behaviour, they might not always act according to this literacy. This is because environmental management tends to be affected by multiple factors; for instance, poverty may prevent people from conducting activities they know to be beneficial for their environment (see Clay et al. 1998, 373).

## 2.6. The historical dimension of environmental changes

The theory approaches the historical dimension of environmental changes as suggested by Vayda and Walters (Vayda and Walters 1999, 169), focusing on identification of the social and biophysical developments that have contributed to the environmental changes in the study area. These developments are approached from two perspectives. The first is that of the local land users, and consequently, the analysis focuses on their past environmental literacy. The study is thus directed to local people's memories, focusing particularly on their memories of environmental changes and the manner in which they perceive their own roles in such changes. Nevertheless, similar to Ruth Lane (Lane 1997, 203-207), the theory acknowledges that the human memory is subjective, selective and tied to life experiences. It is also recognised that people may express differing views of the past environmental development, although it is possible that they also express largely shared memories and experiences.

The second perspective used to approach the historical dimension of environmental changes is that of the outsiders' interpretations and recordings of the study area. Thus, the environment in the past and its changes is approached as interpreted by actors who do not represent the local rural population. The outsiders may use different sources of information about an area, such as consultancy reports, rainfall records or satellite imagery, and they might interpret these sources in various ways. Outsiders' knowledge of the past developments in the area under study are hence also seen as something that inevitably includes at least some amount of subjectivity – even in connection to natural scientific research (for example satellite images of the biophysical environment require interpretation). Furthermore, it is recognised that various interests, such as the economic ones, tend to be present when scale and characteristics of environmental problems are discussed by development organisations and governments who need funding to conduct their programmes.

## 2.7. Summing up: The role of a rural land user in environmental changes

In sum, the nature of environmental changes and the role that various rural land users play in environmental changes is here argued as contextual. Therefore, it is underlined that conclusions about the occurrence of environmental changes, local people's environmental impact and the reasons explaining their environmental behaviour always need to be connected to adequate knowledge of each study area. Moreover, both social and biophysical contexts need to be analysed in different study areas, for numerous factors in both contexts, together with environmental literacy, affect land users' decisions about what kinds of activities to perform. Figure 1 summarises in a brief manner how a rural land user makes decisions on environmental activities.

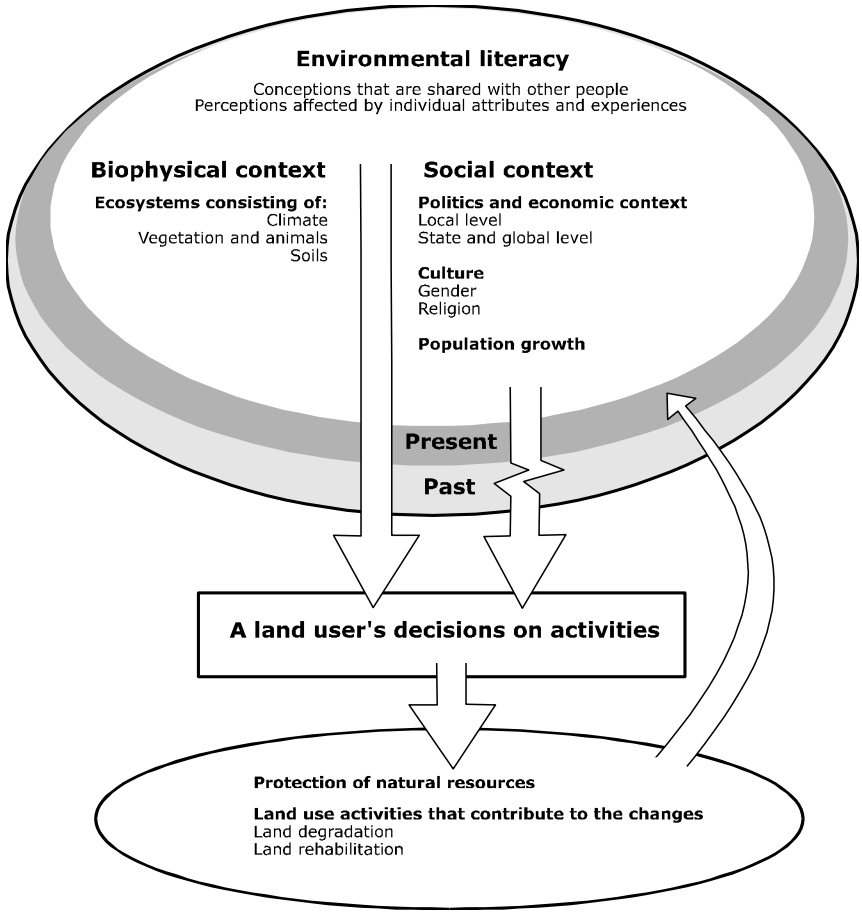


Figure 1. A land user's decision-making in conjunction with environmental activities

Figure 1 claims that a land user's choices of environmental activities are affected by many factors such as the biophysical environment that consists of ecosystems including various parts such as climate, soils and vegetation. Ecosystems are complex and can be studied and analysed in each context in detail. Their characteristics may also be described at a more general level and for instance, *the crucial role of precipitation as the critical factor that regulates the ecosystems and the state of the environment in dry regions* is commonly recognised when drylands are discussed (e.g., Thomas and Middleton 1994, 128-131).

Simultaneously, the social context affects a land user's decisions about her or his environmental activities. It includes various factors that might affect land users' decision-making. These factors may be local by nature, including for example the amount of decision-making power that has been allocated to a rural woman by her community and family over the agricultural land that she manages. Management practices may be also affected by factors that are not proximal to a certain area. For instance, a government may affect local environmental management practices by its economic policies and resulting practices such as displacement of people (Koenig and Diarra 1998, 24). Several factors tend to affect land users simultaneously and many of these factors tend to be connected or intertwined. The cultural construction of gender may be intertwined with politics and control of assets such as land (Agarwal 1997a, 1-9).

The social and ecological contexts in various areas are also perceived to include historical dimensions. From land users' perspectives, the historical dimension refers to such past social and ecological developments they have experienced in the study area that have affected and affect their decision-making concerning environmental activities and consequent practices. However, also outsiders may have ideas and knowledge of the developments of the past, which they have acquired for instance through ecological studies of a discussed area.

The theory of this study assumes that studying land users' roles in environmental changes by combining various actors' environmental literacy of an area, provides multifaceted information of a situation in different contexts. The land users' environmental literacy is developed as a result of their interaction with their biophysical environment and other people. Therefore, this literacy includes perceptions that are shared, although personal experiences and individual interests also affect literacy. Environmental literacy is an important factor that affects the activities a land user performs. A land user may perform a variety of activities, some of which may be connected to long term environmental changes such as land degradation (Olsson and Rapp 1991, 193; Dregne 2002, 110, 122). At the same time, a land user may also conduct activities that are beneficial for an environment,

including protection and rehabilitation activities (Barrera-Bassols and Zinck 2003, 240).

In conclusion, we can see that studies that apply the designed theoretical approach may have to include diverse and even conflicting views of a certain area in the same study. It is likely that not only local land users present a diversity of perceptions perhaps conflicting with outsiders' views, but also outsiders may present varying views of an area under study. Consequently, the role of the researcher becomes particularly significant. The researcher is an actor that collects information from different sources, combines it and presents final conclusions about land users' roles in environmental changes. Hence, the researcher's actions in the field and interpretations of the various types and sources of information affect the findings of any research that is conducted with a similar approach to that adopted for this study.

Nonetheless, although this type of study includes inevitably a clear subjective impact from a researcher, efforts can be also made to alleviate this subjectivity. The efforts included in the theory have been already introduced. The theory emphasised that research on environmental changes should be based on adequate knowledge of each context and that prior to research, a researcher should not be allowed to make a priori decisions of the main reasons causing local environmental practices. Furthermore, the next chapter of methodology discusses on the one hand, how the researcher's personal impact has been acknowledged as part of all qualitative social scientific research, and on the other hand, how a researcher's subjectivity is alleviated in this research.

# 3. Methodology

## 3.1. Underlying principles

This study is multidisciplinary by nature, for it covers topics that have been previously discussed within various disciplines such as anthropology, geography, forestry, sociology, environmental history, economics and ecological sciences. The theoretical framework assumes that people may both cause and alleviate environmental changes through their behaviour. The choices they make about their environmental activities are affected by multiple social and biophysical factors that tend to have their own specific characteristics in different areas.

Recognising the multidisciplinary nature of the study leads to an approach, where positions from several scientific discussions from a variety of research fields are adopted in the theory. The theory of this study also acknowledges explicitly that a social world can be understood to include both material and non-material dimensions. Consequently, both aspects of the social world are studied in this research and its empirical field work. The empirically studied non-material dimension of the social context includes people's own perceptions of their social circumstances. The material dimension includes particularly the research on the socio-economic status of different people and households.

Furthermore, it is recognised that the biophysical environment is an entity with which people interact, while they also perceive and explain it. Moreover, these perceptions and interactions with the environment vary between people. For example, villagers in a tropical rural area and western researchers interested in the same area perceive and interact with its biophysical environments in differing ways. At the same time, the biophysical environment forms its own material entity, something that exists regardless of people's perceptions of it. This view of recognising the material essence of the biophysical environment leads to the acknowledgement that multiple sources of information benefit research on biophysical environments. Therefore, although it is assumed that local people often have detailed knowledge about their home area, also other sources of information are included in this study. In this connection, particularly geographical and ecological studies of the study area are discussed and adopted as a source of natural scientific information of the study area.

Furthermore, it is recognised that although the study uses local people's memories of the past as a source of information on the study area, these memories are characterised by subjectivity. In other words, as Ruth Lane has presented, the study

recognises that the features people distinguish in the landscape, the kinds of changes they observe and their attribution to the causes of changes, all relate to who they are and what their life experiences in that place have been (Lane 1997, 203). Importantly, the study is, however, also based on an assumption that local people's memories of the past may provide information for comprehending the role they have played in environmental changes and reasons for their attitudes and behaviour (see Lane 1997, 204).

### 3.2. Qualitative research methodology

The methods of this study are largely based on qualitative research methodology from the social sciences. The qualitative research methodology has its roots in the early 20th century when anthropological inquiry was further developed and the "Chicago School" began to influence sociological research in the United States (Denzin and Lincoln 2003, 1). Traditionally, the central objective of the qualitative approach has been *to understand and analyse the social world from the point of view of the people that are studied* (Bryman 1988, 61).

Qualitative methodology is an approach that often leads to a relatively open and unstructured research strategy. A researcher enters to field with an open mind, prepared to change her/his approach if necessary and the empirical research material is often collected with various methods (Bryman 1988, 66-67; Silverman 2001, 11). Qualitative research is also based on an idea that a previous theory should determine neither the researched issues nor the analysis of the research material (Bryman 1988, 68, 81). The extent to which previous research and theory can affect a qualitative researcher before entering the field and the role of theory during the fieldwork has nevertheless been debated (Bryman 1988, 83-87; Silverman 2001, 71).

This study acknowledges David Silverman's (Silverman 2001, 2) position, which maintains that research questions, even in qualitative research, are inevitably theoretically informed since researchers have followed scientific discussions. In this study, the researcher familiarised herself with a number of studies of the human-environment interaction and prepared the first draft of research questions before the field work After gathering research material from the field, the researcher modified some of the specific research questions. Some specific research questions were even finalised after the field work, after the researcher had been able to research and analyse the empirical material more in detail. Hence, in this study the formulation of the research questions was a process that commenced prior to empirical fieldwork, continued in the field and was finalised during the analysis of the field material.

## 3.3. Methods of collecting research material

### 3.3.1. Documents and individual interviews

This study used several methods to collect research material, using various sources. The secondary sources of information included documents of the study area. These documents, written by the people outside the local communities, provided, for instance, information about precipitation and vegetation changes in the area (see e.g., Helldén 1991, Mohamed et al. 1995). Simultaneously, the local people and their biophysical environment were also researched with empirical field work, providing a primary source of information for this study. The approach was to collect mainly qualitative information by interviewing local people, although also some quantitative information was sought through interviews.

The most important method used in the field work was semi-structured interviews of individual people. These interviews consisted of open-ended questions (see the lists of questions in appendices 1 and 2). The field work lasted approximately three months and was conducted October – December 2002. In the field, the researcher was supported by two main research assistants. One of them participated in the field work with nomadic pastoralists and the other with farmers. The main task of the assistants was to translate the Arabic language (which all interviewees spoke) into English.

Both of the main research assistants were local women. At the beginning of the field work the researcher was also assisted by a male translator (a forestry researcher) who also supported the researcher's ecological investigations by sharing his knowledge of local tree species. During the course of the interviews it was nevertheless soon realised that the presence of the male interpreter intimidated some of the interviewed women.

The individual interviews included 40 sedentary farmers from one, specific village and 42 nomadic pastoralists from different communities that moved in the study area. The main selection criterion for the samples of both groups was that the selected people would represent adequately the groups studied, including diverse representatives. The interviewed individuals were chosen randomly, but at the same time assuring that approximately half of them were women and half men and that they represented different ages and socio-economic statuses.

The lists of questions for the semi-structured individual interviews were formulated before the researcher began her fieldwork. After the researcher had interviewed some local people, the questions were revised and consequently, a list of main

questions was drafted to guide generally all interviews (these questions can be found in appendices 1 and 2). In addition to the main questions, there were also other topics that were studied with complementary questions that were not included in all individual interviews. In the next chapter covering the results from the field work (chapter 5), it will be noted if the presented information is not based on the "basic list of questions", but fewer interviews.

As a whole, the semi-structured interviews were thus conducted by combining a certain structure with flexibility. The lists of the main questions provided a guide for the researcher, supporting the systematic collection of study material. At the same time, each interview situation was perceived as unique. For instance, if a person was eager to talk about her or his environmental practices the researcher encouraged this with her expressions of interest and with extra questions. If an interviewee was not eager to talk about this topic it was discussed more briefly. It was also common to change the order of questions in order to get the interview flow more naturally based on the interviewee's earlier answers. In some interviews all the questions from the main list were not even asked, for the most talkative respondents had a tendency to answer questions even before they were asked to do so.

Some technical issues affected the interview situations and the collected study material. The most important issue was that the researcher did not speak the same language (Arabic) with the interviewees and it is therefore likely that she has missed information in the process of translation (although the research assistants were actively encouraged to translate all that was said in the interviews). The translated answers were written down by the researcher, who tried to note exactly what the interviewees had said according to the translation. Writing down the answers slowed the pace of the interviews and made the interview situation more "interview like", as opposed to a naturally flowing dialogue.

Using a tape recorder in the interviews would have enabled the researcher to later check with other translators, whether significant information had been left out in the research assistants' translations and whether errors had occurred in the translation. However, although using a tape recorder and another translator would have probably provided additional information, the researcher believes that solely writing down the respondents' answers did not lead to a loss of central information. The interviewees were asked concrete and practical questions such as what they cultivate in their fields or whether the biophysical environment in the study area had changed during the time they have lived there and how it has changed. The answers were also concrete, describing for example that a household's cropland produces less than before. Such information was easy to express with words and rather uncomplicated to note down. Furthermore, since the researcher did not speak

the Arabic language, she would have not benefited from the use of the recorder for non-verbal communication, for she was not herself able to interpret the meaning of pauses and the tone of voices.

Another issue that also affected the interview situations and the collected research material was the researcher herself, who represented a different socio-economic background and culture from those of the interviewees. She made, nevertheless, conscious efforts to alleviate this "distance" between her and the people studied. In practice, the researcher's main concern was to create a free and comfortable atmosphere in the interviews. Nonetheless, since both farmers and nomadic pastoralists often welcomed her warmly in a local culture that emphasises hospitability and sociability, this atmosphere was often created "naturally". In fact, in many situations a dialogue between the researcher and an interviewee occurred immediately after she had been introduced. In these situations, particularly women asked questions about the researcher (her family and her country).

Moreover, the research assistants had an important role in supporting the researcher's interaction with local people. The assistants were in the habit of talking informally with the interviewees before the actual interviews started. These discussions ensured that the interviewees knew who the researcher was, why she was asking various questions and that that the time for the interview was convenient for the interviewee (or that more convenient time would be chosen). In addition, when studying the farmer village selected for the study, the researcher's work was facilitated by the research assistant's personal connections and friends in the study village.

In qualitative social scientific research, researchers' personal attributes and relationships with the studied people are acknowledged to affect the collected empirical material (Bryman 1988, 76-81; Kvale 1996, 147; Flick 2002, 54). Uwe Flick (Flick 2002, 54) describes researchers and their communicative competencies as the main "instrument" in data collection. He emphasises that it is impossible for the qualitative researcher to adopt a neutral role in the field with the people studied. When studying people in the field, a researcher becomes inevitably part of a social context and social situations and thus, has always a certain relationship with the people who are researched. Flick (2002, 54) also believes that adoption of an appropriate and successful role is an important process that affects the type of information a researcher is able to collect.

Furthermore, a qualitative researcher's interpretations are also acknowledged to affect the results of the qualitative studies. A researcher interprets collected data already in the field, and the interpretations and communication with the researched

people affect the further collected research material, for instance in semi-structured qualitative interviews (Kvale 1996, 124-135). After the empirical work, the researcher continues to interpret and analyse the collected material. In addition to the researcher's personal attributes and experiences, these interpretations are also affected by her or his decisions about research questions, theory and methods (Bryman 1988, 72-81; Silverman 2001, 4; Flick 2002, 48). Thus, the researcher is a factor that affects the research and therefore, qualitative research is automatically characterised by some degree of subjectivity.

Nevertheless, similar to Klaus Mäkelä (1990, 59) the researcher believes that this subjectivity can be addressed and alleviated. One way to address subjectivity is to make the research process as transparent as possible. In other words, a reader of a qualitative research report should have enough information about the research process and the researcher's thinking in order to be able to decide whether she/he agrees with a researcher's approach to study certain topics and finally, the interpretations and conclusions presented in the report (Mäkelä 1990, 59). Therefore, efforts are also made in this research report to present as clearly as possible the research process, the information received from divergent sources as well as the discussions and studies that had guided the researchers' thinking and interpretations. These efforts for transparency are aimed at tackling also the issue of *reliability*.

In qualitative research, reliability is complicated by the researchers' acknowledged impact on their collected research material and the flexible manner of collecting information for example in interviews. In quantitative social research reliability is a clear concern, addressed in data collection by designing carefully the questions so that they would be understood exactly similarly by all respondents. Therefore, some social scientists think that reliability is a concern that is not part of qualitative research, but belongs rather to quantitative social studies (Silverman 2001, 226).

Silverman has, however, suggested some measures that would generally improve the reliability of qualitative research such as using standardised methods to write field notes and careful transcribing of audiotapes and even, conducting the analysis of the same research material by several researchers. Tape recording and transcribing procedure was not part of this research, nor did several researchers analyse the empirical data or research material. However, the "basic list" of questions that were asked from all increased the consistency of the field notes, although the questions were not always asked in exactly the same ways. Furthermore, it is assumed that the careful description of the research process, collected research material and the discussions and studies the researcher's

interpretations were based on, contributes positively to the reliability of this research (see Silverman 2001, 229-230).

### 3.3.2. Group discussions, key informant interviews and observation

Although the main method to collect information was the semi-structured individual interviews, several other methods to collect information were also used in the field. These included group discussions, interviews of key informants, and observation. The main role of group discussions was to provide complementary information of the studied communities. The groups normally included 4-7 participants. Women and men were interviewed in separate groups to assure that women would feel free to express themselves. With some groups, the researcher also conducted Participatory Rural Appraisal (PRA) exercises (these exercises could be also called at least Participatory Learning and Action or PLA exercises, see e.g. Pretty et al. 1998; FAO 2004 about these methods to collect information). The group discussion and conducted exercises as well as the type of collected research material will be explained in more detail in the results chapter (chapter 5).

Some information was also collected by interviewing key informants. In ethnographic research, the term key informant has traditionally referred to a specific member of the studied human groups who informs the researchers particularly significantly and deeply about the groups under study. A key informant has been perceived as a person who has access to specific perspectives and observations when a researcher does not have personal access to them or this access is difficult. In other words, the key informant may provide specific and even secret information, but he or she is willing to share his/her knowledge and skills with the researcher (Grönfors 1982, 114; Gilchrist 1999, 354-355).

In this study, the term key informant is, nonetheless, used in a slightly different, more general manner. The term simply refers to a person who provides the researcher with important additional information due to her/his professional expertise and/or social connections. For instance, the researcher received information on the environment of the study area from Sudanese forestry researchers familiar with the area. These key informants were thus specialists of the biophysical environment of the study area and this expertise was used in this research. They did not, however, have a deeper connection with the people studied and the information the researcher received from them was not “secret” or even “sensitive” by nature.

The researcher also observed both the environmental behaviour of people and the biophysical environment. The observation of the biophysical environment concentrated mainly on assessing the state of vegetation cover and indicators of land degradation (largely destroyed vegetation and plants indicating soil poverty). The observation of people included mainly monitoring local people's livelihood activities of collecting firewood, cooking and agricultural activities. The observations were recorded with written notes and photographs.

## 3.4. Analysis of the collected research material

### 3.4.1. Technical organisation

The collected empirical material included written notes from individual interviews, written notes and drawn pictures from group interviews as well as photographs and notes of researcher's observations. In this study, no specific software, developed particularly for qualitative research, was used to organise the research material. To be able to mark and organise the material freely, the handwritten notes were simply typed in a digital format, in Microsoft Word documents. Most of the written research material was from the individual interviews and after the interviews were typed in Word documents, parts from each individual interview could be copied to separate files for further, detailed investigation to provide answers to the particular issues that were studied with field work. These *issues studied, such as local conceptions of the occurred environmental changes, were stated in the specific research questions* that were presented in chapter 1.6.

Each file thus included such extracts from interviews which answered certain issues studied that were included in the research questions. This process where a researcher organises the collected empirical research material according to certain issues, themes or categories is sometimes referred to as "coding". Coding may be conducted in several ways, sometimes including efforts to simultaneously formulate new concepts (see e.g. Marshall 1998, 82, Flick 1998, 179-191). In this study, the coding was nevertheless rather technical and uncomplicated process. The extracts from individual interviews had a "code" attached to them that connected them to a particular person whose interview the extract was taken from (the code included the number of the interview, sex and ethnic group of the interviewee and whether the person was literate or not). Later, these "codes" helped the researcher to compare the differences and similarities in individual answers as well as to compare different groups' answers including women or men, young and old, literate and non-literate people.

As previously mentioned, one of the main ideas guiding qualitative research is that researchers need to conduct their study in a flexible manner, relying on their findings from the field. Hence, qualitative researchers are *not* expected to enter to field with a fixed, unchangeable idea of what they study exactly and how they will later analyse the collected research material. Rather, the researchers remain open to change or modify their study topics if their research material suggests that such changes are needed. This approach was applied to this study as well, for the researcher was critical towards the research questions she had formulated prior to the fieldwork and, as mentioned previously, modified some research questions and simultaneously the issues studied during and even after the fieldwork.

Furthermore, although the semi-structured individual interviews provided the main research material, other material was also available from group and key informant interviews and the researcher's notes of observations. This material was also typed into Word documents and consequently, the relevant parts that answered some research questions could be freely marked, which made the analysis easier.

### 3.4.2. Analysis

In this study, the collected empirical research material was not based on observable variables that can be analysed statistically. Rather, the analysis of the study area and its people was affected by the researcher's interpretations, which were formulated on the basis of the collected empirical research material as well as previous discussions and theory. The analysis of the collected material began already in the field when the researcher interpreted it and made constant decisions on how to proceed with the research and collect more research material. At the same time, also previous studies and theoretical perspectives affected the researcher's analysis from the beginning, although *more profound analysis of the collected data occurred only after the field work.*

This analysis was affected by methods of data collection. Translation used in interviews made the use of specific tools to analyse spoken and written language systematically and in detail problematic. Such analysis techniques include *discourse analysis* and *textual analysis*. Textual analysis has been mainly used to analyse written texts, but both these terms have been also associated with both the analysis of transcribed talk and written texts (propaganda leaflets, newspaper articles etc.) (see Silverman 2001, 122-123, 307; Fairclough 2003, 1-4; Jokinen et al. 2004, 17-24). Another tool of analysis that has been rather widely used, namely *content analysis*, is often associated with a process of analysis that includes establishing categories and thereafter, counting the number of instances when those categories are used in

written texts (Krippendorff 1980, 21-34; Silverman 2001, 122). Although this study did not include this type of (quantitative) content analysis technique, the manner in which Philippe Mayring (Mayring 1983 cited in Flick 1998, 193) has used the term *qualitative content analysis* is applicable to the present study, for he described with the term a rather similar process of analysis as that conducted here.

Similarly to the process of qualitative content analysis described by Mayring, the researcher of this study selected first such parts of the interviews that provided answers to the research questions. Then, differing from Mayring's qualitative content analysis process, she also conducted a simple quantitative analysis of the collected research material that included summarising the environmental conceptions that the interviewed people expressed in brief sentences and counting how many people had expressed the same conception. This quantitative analysis had, however, one crucial difference as compared to the normally applied (quantitative) content analysis. The formulated categories of environmental conceptions were based on what people said in the interviews and hence, the categories were not predetermined by the researcher before analysing the data, which is normally the case when the content analysis is applied (Silverman 2001, 122). Therefore, it seems more appropriate to perceive this analysis technique as a *quantitative summary of qualitative data,* rather than quantitative content analysis (see Alasuutari 1999, 191-195 who presents examples on how qualitative data have been summarised in quantitative manners in tables).

Subsequently, the process of analysis nonetheless continued according to Mayring' qualitative content analysis, for the researcher then analysed the situation of data collection (interview situations and their impact on collected data) and analysed how the technique of data collection (noting down the answers as they were presented and translated without editing) affected the research material. Lastly, she conducted most of the actual interpretation during which other studies and theoretical perspectives affected the interpretations and conclusions she made (see Mayring 1983 cited in Flick 1998, 193). Hence, *the analysis techniques used in this study can be described as qualitative content analysis and quantitative summary of qualitative data*.

Owing to the methodology used, this study could have been presented in various formats, including also the standard (quantitative) scientific report format that is used in here (see the Content that reveals the structure of this research report). In this report format, the results chapter (chapter 5) mainly summarises the collected empirical research material, without profound, theoretically informed analysis that is conducted in the next, discussion chapter. The results chapter includes on the one hand a qualitative, descriptive analysis of the empirical research material and on the other hand, a quantitative summary of the empirical data. Here, the qualitative

analysis is based on comparing and analysing different interviews and the collected empirical research material as a whole.

The researcher is nonetheless aware that she had an impact on the research material while collecting it, organising it and summarising it in the results chapter. To enhance the visibility of the researcher's thinking and interpretations made, the results chapter also includes some direct citations of the studied people's expressions without editing. Citing of research material is rather typical for qualitative research reports, although some qualitative studies have also been criticised for "anecdotalism", referring to a research report that seems to tell a story with suitably chosen anecdotes (forgetting contradictory data) rather than provide an analysis with scientific credibility (Silverman 2001, 34, 304).

However, even before the results chapter, material from literal sources concerning the biophysical environment in the research is presented and analysed in chapter 4 (study area). This analysis continues in chapter 6 (discussion), where outsiders' perceptions of the study area are further discussed and compared to local perceptions. Thus, these chapters provide answers to a specific research question of *outsiders' views and knowledge* of land degradation and environmental rehabilitation.

It is, nonetheless, recognised that the report format used here may not be perceived as the most appropriate form of qualitative research report by some researchers. For instance, Pertti Alasuutari (1999, 289) believes that a qualitative social scientific research report should not include a heavy theoretical framework at the beginning followed by an empirical part, for this might give an impression of a quantitative approach where theory (reflected in hypotheses derived from it) is "tested". Rather, he suggests that in a qualitative research report it is more appropriate to start with some empirical findings and present the research questions as based on empirical material, interpret the empirical findings then further and only in the end conduct the large theoretical discussion.

Here, it is nevertheless believed that a quantitative report format seemed to "fit" to the research process rather well – although resulting in limited analysis in the results chapter. This research is multidisciplinary by nature and presented in such a way that researchers familiar with different research fields could follow this research report. Since the qualitative approach is not typical for ecological sciences, it is hoped that the familiar format of the report would enhance the understanding of the used methodology and findings of this study also by natural scientists.

# 4. Study area: biophysical and social context with historical perspective

## 4.1. History of desertification

Outsiders have identified and discussed environmental problems in the dry regions of Africa since colonial times. The French colonialists expressed concerns of desiccation and decrease of vegetation in the Sahel region already in the beginning of the 1920s, based on their field studies at locations of present Mali, Mauritania and Senegal. In the 1930s, the discussion of environmental problems in the Sahel intensified owing to the impact of Edward Percy Stebbing, a British colonial forester with experience in India. Based on his field assessments in West Africa in the dry season, Stebbing claimed that human activities of burning and cutting the vegetation in savanna woodlands transformed them into man-made grass savannas. These savannas were then downgraded into desert by ecological processes (Mortimore 1989, 13-14; Swift 1995, 75-77).

Later, Stebbing's claims were criticised by the members of the Anglo-French Forestry Commission, who conducted further field assessments of environmental degradation, as had been recommended by Stebbing himself. Based on studies in Nigeria and Niger in 1936-1937, the Commission concluded that there existed no apparent danger of desert encroachment and desiccation, but that degradation of the woody vegetation had taken place in some areas. Furthermore, the Commission suspected that uncontrolled expansion of shifting cultivation was most likely the main reason causing the degradation of woodlands. However, some members of the Commission acknowledged that with sufficiently long fallow periods the shifting cultivation would not damage the soil (Mortimore 1989, 13-14; Swift 1995, 75-77).

It is believed that the term desertification was probably first used in 1949 by a French forester, Andre Aubréville, who used the term in order to describe destructive ecological processes occurring in dry regions of West Africa (Mortimore 1989, 12; Swift 1995, 77). The ecological processes included "savannisation", erosion and desert encroachment. Aubréville saw local people as the main actors triggering these processes and he was particularly concerned about local people's practices to cut trees, cultivate intensively and to use fire in the farming systems. He believed that these activities had resulted in transformation of forests into savannas and that the savannas could then develop into deserts via massive erosion (Aubréville 1949, 309-310, 341-343; Mortimore 1989, 14).

Later, in the post-colonial era, the idea of local people's negative impact on their environment has been an important element in the international discussion on

desertification (Swift 1995, 83). Nonetheless, shortly after Aubréville's (1949) research, in the 1950s and 1960s, the issue of desertification was not a yet a significant concern for the international community. The revival of the concept occurred in the 1970s, as the result of the long lasting drought of the Sahel, which commenced in the latter part of the 1960s. The drought and its associated consequences such as famine attracted world-wide attention, which resulted in a sizeable programme of international aid mainly in the form of food. In addition, during the drought years concerns were raised in the international community that the environmental recovery might be a long process and that some irreversible damage to the environment may have occurred in drought-affected areas. To discuss the presumed desertification problem, the United Nations Conference of Desertification (UNCOD) was organised in Nairobi 1977 (Swift 1995, 77-81; Thomas and Middleton 1995, 28-29).

According to Jeromy Swift (Swift 1995, 80) many scientists involved in the UNCOD were uncertain about the causes and extent of desertification. In the UNCOD's final report the desertification process was described as follows: "Desertification is the diminution or destruction of the biological potential of the land, and can lead ultimately to desert-like conditions". The increased intensity of land use due to population growth (exacerbated by drought) was seen as the main cause of desertification. (UNCOD 1978, 6). After UNCOD, the next widely-agreed description of desertification was recorded in Agenda 21 (see UN Department of Economic and Social Affairs 2004), which was published in connection with the United Nations Conference on Environment and Development (UNCED) organised in Rio de Janeiro in 1992. Later, the Agenda 21 definition was included in the United Nations Convention to Combat Desertification (UNCCD) in 1994. As described in chapter 1.2 of this research report, the UNCCD described desertification as *land degradation* in arid, semiarid and dry subhumid areas, caused by various factors, including climatic variations and human activities (United Nations 1994, 4).

Generally, since Aubréville's introduction of the term desertification, a great number of descriptions of the phenomenon have been published (see Glantz and Orlovski 1983; Olsson 1993a, 23; United Nations 1994, 4). Some of the descriptions associate desertification to desert encroachment or ecological processes leading to "desert like conditions" (e.g., UNCOD 1978, 6). Thus, in these descriptions desertification has been understood as severe land degradation, which can lead to deserts. Moreover, although the description of desertification would not include an explicit idea of processes leading to deserts, the word "desert" is inherently part of the term *desert*ification.

In this study, it is assumed, however, that land degradation is a context-specific phenomenon that may occur with varying intensity even in a small area (Warren et al. 2001, 80-81; Warren 2002, 453-457). Furthermore, it is acknowledged that although droughts and human activities might degrade the environment in dryland areas, the ecosystems of these areas are often resilient. The term resiliency refers to nature's or an ecosystem's capability to recover from disturbances (Olsson 1993a, 28; Stilling 2002, 378). Hence, although a dry region would seem highly affected by drought during certain years, it is possible that a sufficiently increased rainfall will "repair" a lot of the damage that has taken place (Thomas and Middleton 1995, 128-130, 148). Therefore, due to the above-mentioned factors, the term land degradation is preferred in this study instead of the term desertification.

### 4.2. The occurrence and scale of land degradation in the study area

The study area lies in the centre of Sudan, in the southern part of North Kordofan State within an area of 12°-14°N and 30°-32°E. The sedentary farmers studied lived in a village, which is situated approximately 130 km east of the capital of the state, El Obeid. The nomadic pastoralists moved and lived in an area around El Obeid stretching from the immediate surroundings of the town to approximately 80 km east and 40 kilometres south of it.

The nomadic pastoralists can be divided into two main groups, namely those groups that earn their main livelihood from camels (*Abbala*[2] in Arabic) or cattle *(Baqqara* in Arabic). The cattle herders have traditionally practiced a regular migration pattern, moving each year in North-South direction, so that the El Obeid area has been at the northern end of their migratory route. They have entered into the study area during the rainy season and stayed there two to three months. After the rains they have returned back in a southerly direction (Niamir-Fuller 2000, 272).

The camel pastoralists have also traditionally followed a regular, seasonal movement pattern (known as transhumance). Their migration route has passed the study area twice a year; they have entered the area from South-East and continued to North-Western direction and then returned back (El-Hag et al. 2002, 23). The traditional migration pattern is still practiced by many pastoralists, although a number of modifications of this migration have also emerged. Figure 2 shows that

[2] In this research report, the Arabic words are mainly transliterated according to literary language. However, a group of words (qoz, gardud, neem, karkadeh, El Obeid, El Ain, Omar el Bashir) are transliterated differently, using already widely-used versions.

the study also includes the El Ain Forest Reserve, a forest area of 11 850 hectares that is situated 26 kilometres east of El Obeid (Egeimi et al. 2003, 5, 17).

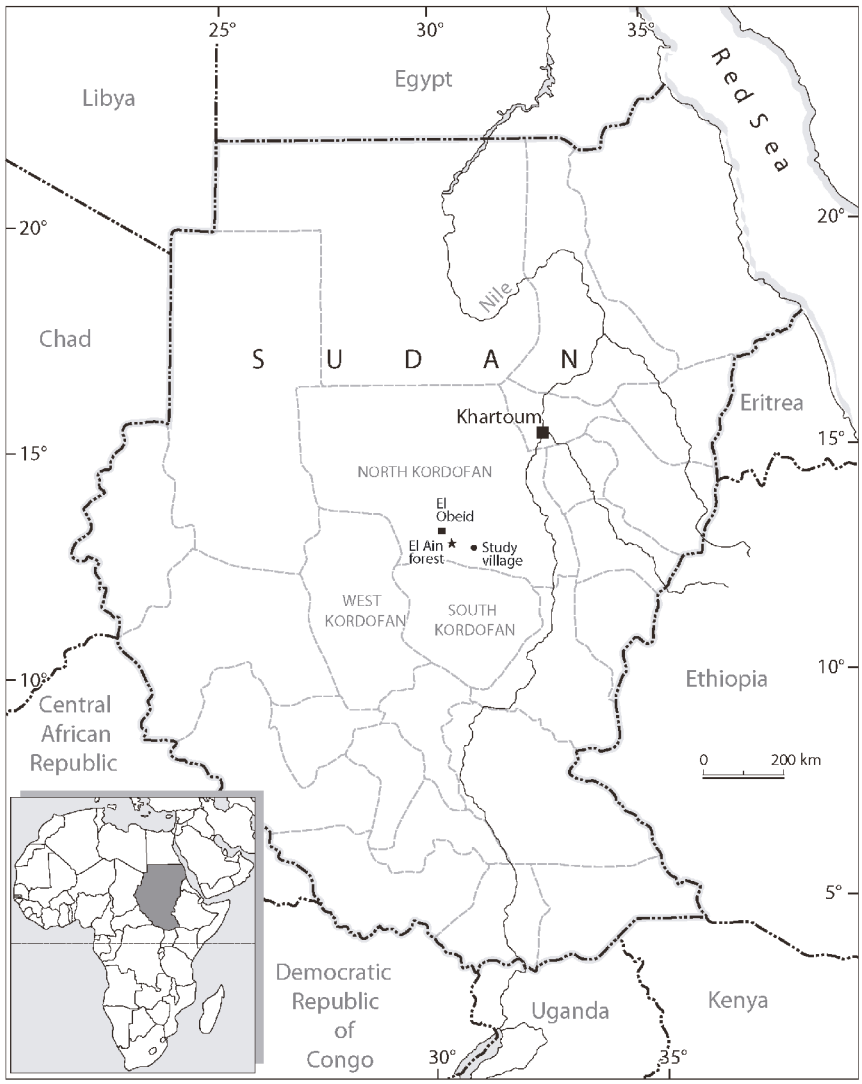


Figure 2. Map of Sudan with the study area (Hares et al. 2006, 134)

There exist multiple perceptions of how land degradation has affected the environment and the lives of rural people in the study area. For example, the significance of land degradation in the food deficits that have occurred there during recent decades has been viewed in differing ways. Simultaneously, it is clear that

the government's political decisions have had impacts on the lives of rural people in North Kordofan in connection with droughts and subsequent famines.
During the long-lasting Sahelian drought in the late 1960s and at the beginning of the 1970s, Jaafar Nimeiri's government in Sudan adopted a strategy in which food shortages resulting from drought years were tackled with internal activities. Active measures were taken to fight against famine, when food from the surplus-producing east was transported to the west where crops had been lost. The Sudan Socialist Party (the sole accepted party at the time), local councils and Red Crescent committees organised food distributions. As a result, famine was largely avoided.

The next long lasting drought that hit the Sudan in the 1980s was not, however, addressed with significant internal actions. In fact, when hunger threatened North Kordofan and some other areas in the early 1980s, President Nimeiri first denied that the problem existed. Action to address the situation by the Sudanese government was not even taken in 1984, when the world's attention was drawn to the famine in Sudan by international organisations. Only after Nimeiri lost power to a new regime, did the Sudanese government finally turn to the international community for emergency aid in 1985 (de Waal 1997, 86-93).

Tesfaye Teklu and others have also claimed that institutional weaknesses, namely the absence of a famine policy and a permanent institution to deal with famine preparedness, contributed to the famine that occurred in Sudan after the great drought in 1984-1985. In addition, the government's objective to modernise agriculture contributed to the famine, since the promotion of large-scale, capital-intensive technology contributed to the neglect of smallholders and deterioration of ecological balance. Traditional smallholders suffered from low levels of food production and income, which reduced their preparedness to survive crop failures for instance in the Kordofan area (Teklu et al. 1991, 17-19).

Moreover, Mustafa Khogali (Khogali 1991, 205-206) has studied farmers in the Umm Ruwaba district of North Kordofan, where the farmer village of this study is also situated. He has summarised the reasons behind the famine in this area during the 1980s as: low rainfall that affected the crops; pest attacks; abandonment of the tradition of storing grain, and the government policy of commercialising agriculture. He has claimed that the farmers previously produced food crops mainly for their own private consumption and during the good rainfall years they were able to store the surplus. This surplus grain was then used in years with low rainfall and production. During the 20th century, the farmers nonetheless commenced to grow cash crops as well and most of the households gradually allocated around half of their cropland to cash crops. When the drought occurred in the 1980s people had not prepared themselves by storing part of their harvests.

Lennart Olsson (Olsson 1993b, 401- 402) has stated that it is difficult to estimate how many people died or migrated out of Kordofan during the drought, but the numbers are significant. The famine tragedy was further deepened by food speculation, for traders were allowed to sell grain at high prices in the rural markets and many farmers who had lost their crops could not afford to buy their food. Banks and other financial institutions further contributed to the famine by providing loans for food and livestock speculators. Therefore, it seems that land degradation cannot be perceived to play a key role in causing the famine that took place in the study area in 1984-1985. Rather, it seems that the limited precipitation combined with the policies and actions of the central government played a more significant role in this connection.

Nevertheless, land degradation and its impacts on the environment and people in the study area have attracted specific attention. In 1975 Hugh Lamprey, an ecologist and wildlife biologist, was commissioned by the Sudanese government, UNEP (United Nations Environmental Programme) and UNESCO (United Nations Educational, Scientific and Cultural Organization) to investigate desertification in Sudan. After three weeks' work of ground and aerial surveys, he wrote a report that was never officially published (Swift 1995, 78), although an edited summary was published in 1988 (Lamprey 1988). In the report, Lamprey claimed that the Sahara had shifted 90-100 km southward during 1958-1975, which would indicate a southward shift of approximately 5.5 kilometres a year (Lamprey 1988, 2; Swift 1995, 78) and therefore also suggested that the study area in North Kordofan was threatened by a rapid desert encroachment.

Lamprey's report had an important impact on the global desertification discussion and in fact, over ten years after the officially unpublished report, it was claimed that all the quantitative statements about the worldwide desert expansion had relied so far either on Lamprey's study or use of unsubstantiated assertions (Dregne and Tucker 1988, 17). At the same time, particularly a group of geographers from the University of Lund started to question Lamprey's findings of a rapid southward Sahara encroachment in Sudan. After Lamprey, they studied the alleged occurrence of desertification in Kordofan and elsewhere in Sudan by combining remote-sensing techniques, field observations, national statistics and spatial modelling.

The Lund geographers included Ulf Helldén (Helldén 1988 and 1991), Lennart Olsson (Olsson, L. 1985, 1993a and 1993b) Katarina Olsson, (Olsson K. 1985) Eva Ahlcrona (Ahlcrona 1988) and Andreas Rapp (see Olsson and Rapp 1991). Based on their studies Ulf Helldén reported that no systematic southward encroachment of the Sahara desert had occurred in Sudan during the 1970s. The droughts that

occurred in the period between the end of 1960s and the mid-1980s had decreased the amount of vegetation, but the vegetation had largely recovered and increased during the years of increased precipitation (Helldén 1991, 379-380).

The methods that the Lund researchers used had, however, some limitations. The information that could be retrieved from the satellite images was not very detailed, for Lennart Olsson described it impossible to distinguish between some vegetation types in the satellite images taken during dry season (Olsson, L. 1985, 64-65). Moreover, the field studies that were implemented by Olsson to verify and complement the information from satellite and aerial pictures were conducted at different times as compared to when the analysed pictures were taken. Hence, he recognised in his doctoral dissertation that "substantial changes can have occurred in the landscape from the time of recording the Landsat images in 1979 to the field data sampling in February 1982" (Olsson, L. 1985, 64).

Nevertheless, the Lund researchers' studies suggest that Lamprey's perceptions of desertification in the study area exaggerated the scale and intensity of the problem. The droughts that had occurred in the area had not led to massive ecological degradation, since the vegetation cover had again increased during the years of good rainfall. The ability of the vegetation to "recover" from droughts was again indicated by a study conducted by a group of Sudanese researchers in 1995. They found that during 1994, when the mean annual rainfall in the area was over 540 mm (Metrological Department 2002), a significant biomass recovery occurred in the area and, further, also some tree and grass species that had been formerly believed by some researchers to have disappeared from some "deserted" areas, reappeared (Mohammed et al. 1995).

Based on the above, it can be concluded that the study area is not in the process of developing rapidly into a desert-like environment. Rather, it seems that the severity of environmental changes has been exaggerated in the past – perhaps owing to the need to receive development funding. Nonetheless, to determine the significance or even the overall occurrence of land degradation still poses a challenge in the area. Land degradation can vary even in a very small area, and in many places verifying the exact occurrence and scale of the phenomenon would require detailed ecological studies at different sites (Warren 2002, 454).

It is assumed in this study, however, that severe land degradation can be observed visually. During the field work for this study, it was observed that at the end of the rainy season, visible environmental degradation could be observed in some specific places in the study area. The vegetation was observed as being particularly destroyed in a zone of several kilometres around the town El Obeid, where also

*Calotropis procera* (Ait.) Ait. f.; a shrub known to survive in and indicate disturbed areas (El Amin 1990, 377), grew in large quantities.

The vegetation was also extremely limited around the smaller town of Umm Ruwaba in the study area, in the vicinity of excavated water reservoirs (*hafirs*) used by a large number of domestic animals and in an area which has been formerly used for mechanised agriculture. Trees were also observed to grow particularly scattered in the common property land in the vicinity of the farmer village studied and also *Calotropis procera* grew within and outside the village. Observations of largely destroyed vegetation around large towns and water reservoirs, agree with the conception that environmental degradation tends to occur in areas of large human and animal concentrations (see e.g., Al-Awad et. al 1985, 17).

Khogali has also claimed that the farmers have commonly reduced the fallow time in their farming systems and therefore it is possible that land degradation occurred in croplands of the study area (Khogali 1991, 205). People may, however, also rehabilitate their croplands for instance by using organic fertilizers and their croplands receive also natural inputs. In addition to precipitation, these inputs are obtained from various sources such as decomposing leaves, chemical and physical decomposition of the underlying rock (the process of known as weathering) and in some situations, from dust (Warren et al. 2001, 80-82).

Excluding the central importance of precipitation, these natural inputs did not, however, play significant roles in the study area. The farmer village studied was on predominantly sandy soil, which had been developed on stabilised sand dunes (Grove & Warren 1968, 204; Olsson, L. 1985, 13-14) which are not significantly affected by either rock breakdown or additions from the wind (Warren et al. 2001, 82). Many of the sandy soils are nonetheless deep enough to withstand erosion for a long time, before the bedrock is exposed. Therefore, it has been suggested that the indifference of many Sahelian farmers to high rates of soil loss on sandy soils due to erosion may reflect their conception that erosion does not seriously damage productivity in the short term, until the soils are very thin (Warren et. al 2001, 82).

### 4.3. Reasons behind land degradation in the study area

The reasons behind land degradation in the study area have been explained slightly differently, even by the researchers from the University of Lund. Ulf Helldén (Helldén 1991, 380) has expressed doubts whether human behaviour has significantly affected the environmental changes in the study area at all, stressing that precipitation has been the major factor causing changes in vegetation cover.

Although acknowledging the significance of the climatic fluctuations, Katarina Olsson and Andreas Rapp (Olsson and Rapp 1991) have in turn explicitly stated that human behaviour is a factor that has contributed to the environmental degradation. They have claimed that intensive wood cutting, animal grazing and crop cultivation have all degraded the environment in Kordofan (Olsson and Rapp 1991, 193).

In fact, Anders Rapp had presented already in the 1970s how human-caused desertification seemed to have occurred in dry regions around the Sahara desert. He believed that this desertification process had included two phases. In the first phase, people had expanded and intensified their land use into marginal areas during wet years. The land use activities had included increased grazing, cultivation of new land, and wood collection around new settlements. In the second phase these marginal areas had been affected by wind erosion during dry periods or by water erosion during heavy rainstorms, which have caused desertification (Rapp 1976, 12-13).

These ideas seem to contradict the findings of a study conducted in the study area later on by Ulf Helldén. He namely found out that an explosive expansion of the areas cultivated had occurred in the study area at the end of the 1960s, during the first great Sahelian drought, but the areas allocated for cultivation had again decreased after the drought (Helldén 1988, 10). In order to explain the *increase of areas allocated for cultivation during the drought*, Helldén first acknowledged that the major part of Sudan Government's water supply programme was conducted in the 1960s and that the availability of new water resources might have resulted in the cultivation of areas which could not be reached earlier because of lack of drinking water. Despite the increased availability of water in wells, he nevertheless perceived the drastic expansion of cultivation during the drought years mainly as a response of farmers to declining crop productivity and believed that owing to this response, the farmers succeeded in keeping up the food production fairly well during the drought (Helldén 1988, 10).

Helldén's study hence suggested that people may in fact expand their cultivation activities during droughts to secure an adequate food production, which seems to present a contrasting viewpoint to Rapp's earlier views of land-use expansion and intensification during wet years. As a whole, the research area has experienced a clear expansion of private, agricultural land during the last decades (Ministry of Agriculture 2002; Egeimi et al. 2005, 10). The increase in private lands might have contributed to land degradation in common property land, as less such land is now available for common use and, consequently, the natural resources available on such land are now used in a more intensive manner.

Simultaneously, it is clear that in addition to human and animal impacts, rainfall fluctuations have affected the environment in the study area. In the past, the vegetation had recovered rather well from the droughts during years of good rainfall – although visible land degradation occurred in some specific areas. Consequently, it is here assumed that *land degradation occurs in the study area to varying degrees and that people have contributed to the degradation in some specific areas.*

## 4.4. Biophysical characteristics of the study area

### 4.4.1. Climate: limited, erratic precipitation and high temperatures

The precipitation in Sudan increases from north to south, and the vast country includes several climate and vegetation zones, but predominantly the country is covered by arid and semi-arid areas (UNEP 1997, 7; Republic of the Sudan 2003, 2). The study area is also a dry region where the shortage of water is a critical issue, since the precipitation is limited and highly variable.

The area benefits from one rainy season, which lasts normally from May/June to September/October. The rainy season is regulated by movements of the Inter-Tropical Convergence Zone (ITCZ) in the atmosphere, which oscillates northwards and southwards. When the zone moves northward, moist southern air meets hot northern winds and rains occur. During the rainy season the converging air masses prevail over the area until the ITCZ moves southwards, after which the dry season starts again (Western Sudan Agricultural Research Project 1982, 17; Republic of the Sudan 2003, 4).

The study area has been affected by a particularly dry episode of the Sahel that began in the late 1960s and lasted until 1991. To obtain information on the precipitation in this episode (and in the 20th century as a whole), records of the mean annual precipitation in El Obeid were studied in conjunction with this study. It is of importance to recognise, however, that the precipitation varies at the local level, and therefore, the rainfall records of El Obeid can only illustrate rough trends of the mean annual rainfall in the area as a whole.

The mean annual precipitation in El Obeid during from 1902 until 1984 is here presented as it was summarised in Lennart Olsson's doctoral dissertation (Olsson, L. 1985, 103-105), based on rainfall records from Sudan Meteorological Department's station in El Obeid. The Figure 3 reveals that *the trend of annual mean precipitation* (linear line*) from 1902 until 1984 was only very slightly decreasing, but during this period the mean annual precipitation* (dashed line) *varied considerably between years*: While

some years were characterised by rainfall of less than 200mm, in some other years the mean annual rainfall reached over 600mm. However, *when a shorter time period from 1950 until 1984 is focused upon, the trend of annual mean precipitation is more clearly decreasing* (see Figure 4).

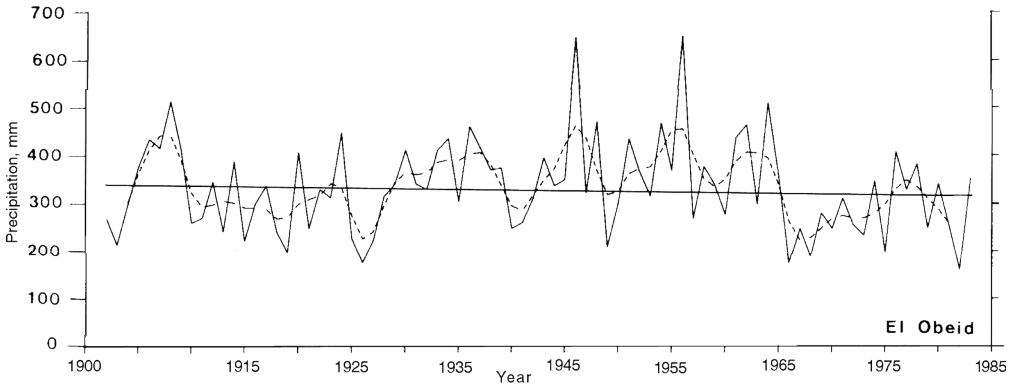


Figure 3. Annual mean precipitation in El Obeid from 1902 until 1984 (Olsson, L. 1985, 103)

The figure presents mean annual precipitation each year (the highly curved line), the linear trend of rain (straight line) and the average annual precipitation with five years' smoothing filter (dashed line), which is based on calculating an average temperature after each five years period.

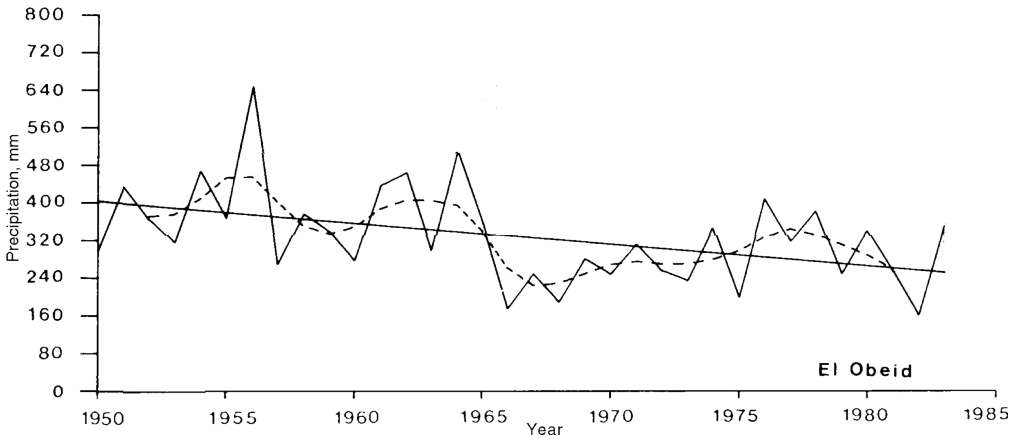


Figure 4. Annual mean precipitation in El Obeid from 1950 until 1984 (Olsson, L. 1985, 105) For explanation, see Figure 3.

The declining trend in rainfall from 1950 until 1984 was caused by two long-lasting droughts, which affected El Obeid from the mid 1960s until the mid 1970s and in the first half of the 1980s. The next figure (Figure 5) presents the trend of mean annual precipitation in El Obeid from 1984 until 2002. The figure shows that a rather low annual precipitation continued to occur in the study area during the 1980s and in the beginning of the 1990s; particularly in 1990, the recorded mean annual rainfall was low, accounting to only 207mm (Meteorological Department 2002). In the 1990s, the precipitation continued to be characterised by a great variability, but the trend in mean annual precipitation generally rose (the linear trend line was calculated as indicated in the figure) so that the average value of the mean annual precipitation was 382 mm during the period 1990-2001 (Meteorological Department 2002).

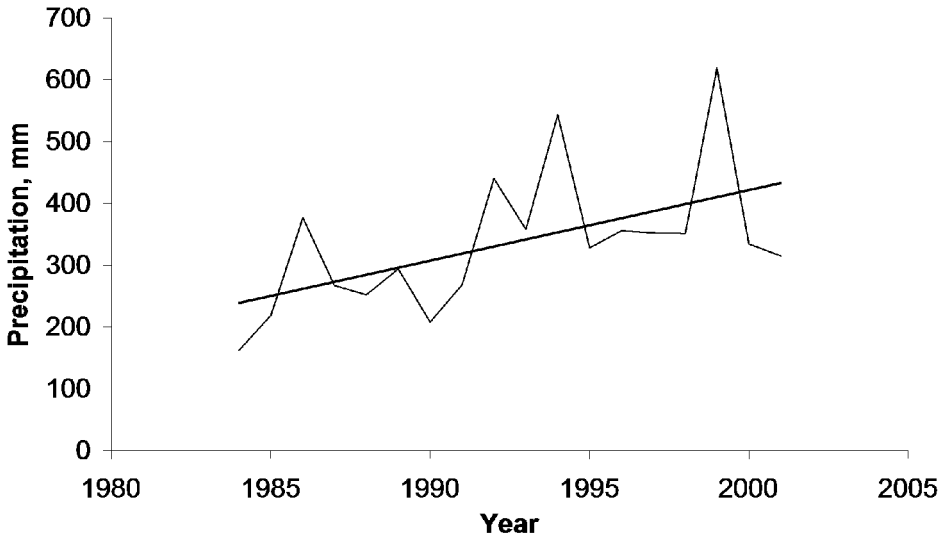


Figure 5. Annual mean precipitation in El Obeid from 1984 until 2002
The highly curved line shows the mean annual precipitation.
The rising straight line is the trend line (equation: y = 11, 427x – 22433).

Sources of precipitation records:
Years 1984-1987: Sudan Meteorological Department's cited in Mohamed et al. (1995).
Years 1987-2002: Sudan Meteorological Department's station in El Obeid (2002).

In sum, it can be concluded that although the study area has been affected by severe droughts in the 20th century, years of relatively abundant rainfall occurred as well. As a consequence, *the amount of the overall precipitation received had not decreased during the 20th century*. This fact does not, however, suggest that the biophysical circumstances in the study area had not become more demanding for the people and

animals in the area. Mike Hulme (Hulme 2001, 19) has noted that the ecological and social systems in the Sahel area have traditionally adapted to the *variability* in the rainfall supply and not to its average levels. In the Sahel, the variability of the rainfall in space and from year to year is more important to people and to the environment than some rainfall averages, for instance, over 20 or 100 years (Hulme 2001, 19).

In this connection, it is recognised that the two long-lasting, extremely dry periods that occurred in the area during 1966-1975 and 1981-1985 included some years with an exceptionally low rainfall, even when the precipitation statistics from the whole century are considered. These severe droughts also took place in an exceptionally short period of approximately 20 years, and there were no years with an exceptionally high annual rainfall between these two droughts.

Furthermore, it needs to be recognised that the rainfall patterns do not only vary in different years, but also within years. If rain occurs as fierce storms, the rainy season benefits the area less; particularly since the common soil type in the area is sandy soil, with poor water holding capacity (El-Dukheri 1997, 12). Thus, even though the total rainfall during a year might not be exceptionally limited, the crops and the overall vegetation can suffer from serious shortages of water, if the rain has been received in a few strong storms. Strong storms also contribute to surface erosion and damage vegetation.

Available water resources in the area are also highly sensitive to climate variation. Surface water in the area consists solely of seasonal streams, which usually flow during July and August. No permanent rivers exist in the area (Republic of the Sudan 2003, 54-55 ). To store rain water, reservoirs, locally known as *hafirs* have been established. *Hafirs* are important sources of water for people and animals; in fact, it has been estimated that *hafirs* provide approximately 80 percent of the water that is available for consumption in the North Kordofan State (Office of the UN Resident and Humanitarian Coordinator for Sudan 2003, 11). At the same time, wells including groundwater are also needed for drinking, but although the government has built numerous wells in the study area, the amount of groundwater in North Kordofan is generally limited and insufficient to meet human and animal needs (Republic of the Sudan 2003, 60; Office of the UN Resident and Humanitarian Coordinator for Sudan 2003, 11).

The problem of limited water resources in the area is not solely the result of rainfall patterns, vegetation or soils. In fact, temperatures play an important role in connection with the water problem as well, since high temperatures contribute to high evaporation rates. The study area is characterised by high temperatures;

according to Le Houérou and Popov (1981, 31) the mean annual temperature in El Obeid is 27°C. It is a semi-arid area, where solar radiation and high temperatures contribute to a high P/PET ratio, which is there higher than or equal to 0.20 and less than 0.50 (UNEP 1997, 5). So, according to this estimation, potential evapotranspiration in the study area would amount to more than twice to five times annual precipitation.

### 4.4.2. Soil: demanding soil types for agriculture

The most common soil type in the study area is sandy soil, locally known as *qoz* (Olsson L. 1985, 13). This soil, which was also cultivated by the sedentary farmers studied, contains high quantities of coarse-textured sand and very little of fine-textured silt and clay. As a result of this coarse texture, the soil has high water permeability and poor water holding capacity. The soil also contains limited amounts of mineral nutrients (such as nitrogen and phosphorus) and organic matter. Consequently, the *qoz* soil is inherently poor (Olsson L. 1985, 14; Zaroug 2000, 6). This soil is, nonetheless, suitable for traditional farming techniques, since it is easy to cultivate with hand tools (El-Dukheri 1997, 12).

The majority of the cultivating nomadic pastoralists studied had their fields, however, on *gardud* soil that dominates the area south of El Obeid (Olsson, L. 1985, 13). *Gardud* is a non-cracking clay soil that also contains significant amounts of sand. *Gardud* has a more compact structure than *qoz* and is also characterised by a hard surface, which is why it is difficult to cultivate *gardud* with traditional hand tools. Although *gardud* would have better potential for retaining water and nutrients because of its structure, a lot of water is lost as runoff (Olsson L. 1985, 14; El-Dukheri 1997, 12 ).

### 4.4.3. Mosaic landscape with savanna woodland vegetation

The natural vegetation of the study area has been described in several publications as *low rainfall woodland savanna*. This description is based on Harrison and Jackson's classification, which was published already in 1958 (see Harrison and Jackson 1958 cited e.g. in El-Dukheri 1997,11; in Zaroug 2000, 8, and in Ballal 2002, 12 ). To describe the current vegetation solely depending on this source of information would not be sufficient, since climate, herded animals and people have modified the area for decades since this early description. However, regardless of whether a low rainfall savanna zone in Sudan is defined as an area of mean annual rainfall of 300-1000mm (El-Dukheri 1997, 11) or 300-900mm (Republic of the Sudan 2003, 3) or 300-800mm (Zaroug 2000,8), the study area would qualify for the low rainfall category.

Furthermore, based on the researcher's observations of the vegetation in the study area, discussions with local forestry professionals[3] and the forestry-related terminology presented in the dictionary by The Society of American Foresters, it is concluded that the area could be still described as woodland savanna.

"The Dictionary of Forestry" by The Society of American Foresters describes woodland either simply as a forest area or "a plant community in which, in contrast to a typical forest, the trees are often small, characteristically short-boled relative to their crown depth, and forming only an open canopy with the intervening area being occupied by lower vegetation, commonly grass". The term savanna refers to a either tropical or sub-tropical grassland with scattering trees or shrubs and *savanna woodland* refers to "a more or less open tropical or subtropical woodland having an undergrowth mainly of grasses, the trees being of moderate height and generally deciduous or if evergreen, tending to have small leaves" (Helms 1998, 159, 200).

In the study area, the ground layer of the common land was dominated by grasses. The generally low woody vegetation grew scattered throughout the common property land or was included in the farming systems. *Acacia senegal* (L.) Willd., locally known as *hashab*, was the most common tree on sandy soils, where it was commonly found in farming systems. On *gardud* soils, *Acacia mellifera* (Vahl) Benth., locally known as *kitir*, occurred commonly, as was indicated already by Harrison and Jackson (1958; cited in El-Dukheri 1997, 14). In towns and sedentary farmer villages, the neem tree, *Azadirachta indica A. Juss.,* was commonly planted and particularly valued as a shade tree.

Moreover, it can be noted that in the classification used in FAO reports (FAO and EC 2002; Salih, 2000 ) vegetation in Sudan is divided in a different manner. Following this classification the vegetation of the study area could be described as *acacia short grass scrub* (see also Al-Awad et. al 1985, 19). It is also noted that large sections of the study area are not characterised by natural vegetation. Therefore, rather than perceiving the area solely as a woodland savanna or acacia short grass scrub, it is more appropriate to view it as a *landscape that has a mosaic structure* including divergent types of land uses. In addition to agricultural fields and the woodland savanna, also the small El Ain forest area, with its distinct vegetation, was included in the landscape studied.

[3] Dr. Mukhtar Ballal and Dr. Abdalla Gaafar Mohamed; see appendix 3.

## 4.5. Land tenure and management of public resources

Land tenure regimes determine who uses the natural resources and how. In Sudan, both the customary rights and the statutory laws affect land tenure and property rights. Who actually has the ownership of the land in the rural areas of Sudan is therefore somewhat unclear. According to the Unregistered Land Act that was published in 1970, land is officially owned by the government, excluding certain lands (1 % of Sudan's land area) that have been registered before 1970 as private lands under a 1929 law (World Bank 2003, 103).

Simultaneously, the traditional land tenure system still greatly regulates land use in the study area. According to the traditional land tenure system, the farming communities have been allocated certain areas around their villages that are governed by the village leaders (*sheiks*) who grant user rights to these lands. In North Kordofan, the most common form of land acquisition these days is inheritance (El-Dukheri 1997, 52). A *sheikh* can nevertheless still rent unallocated lands to villagers, newcomers or even outsiders of his village. (El-Dukheri 1997, 50-51; Kevane 1997, 296-300).

In the study area, the central government has not extensively interfered in the traditional land tenure system. It has, however, rented some common property land for private businesses. As a result, for instance the Saudi-owned Malaysian African Asian Company was able to start an *Acacia senegal* plantation in the area to produce gum arabic (Hussein Adam Abdalla 2002, personal communication; see appendix 3). The decrease of common property land in the area (Ministry of Agriculture 2002, Egeimi et al. 2005, 10) had increased particularly the pastoralists' challenges in making their livelihood in the area.

Public resource management has been revised several times in Sudan in the1990s and at the beginning of the 21st century (World Bank 2003, 75-76; The Office of the UN Resident and Humanitarian Coordinator for Sudan 2003, 2-3). In 2002, during the time of the field work for this study, public resource management and administration were organised at three levels; federal, state and local. Under the federal administration, there existed 26 states (such as North Kordofan State), which were headed by governors and administered by decentralised governments. States were further divided into provinces. Under the provinces, there were so called localities, which represented communities. The federal government had delegated important services such as basic education, primary health care and water supply to the states and local communities. They lacked, however, both revenues and administrative capacity to implement the services (World Bank 2003, 75-76).

## 4.6. Economic setting

The majority of people in Sudan earn their livelihood from agriculture, which is the mainstay of the Sudanese economy in terms of its contribution to GDP. In 2002 the agricultural sector contributed 39 %, industry 18 % and services 43 % to the country's GDP at factor costs (World Bank 2003, 3). Before the late 1990s, the agricultural sector also provided the majority of the export merchandise and earnings for Sudan. However, because of the increased utilisation of the oil resources, oil is today the most important export commodity. In 2001 Sudan received 74.7 % of its export incomes from crude oil. Other important merchandise that contributed to export earnings in 2001 were sesame (6.1 %); cotton (2.6 % ); gum arabic (1.4 %); livestock (0.9 %); sugar (0.7 %), and groundnut (0.5 %) (World Bank 2003, 4).

Since independence in 1956, the economy of Sudan has either stagnated or developed slowly. The slow growth has been influenced by various factors such as the long and costly civil war. The war started even before Sudan got its independence from the British in 1956 and was ongoing in 1955–1972 and 1983–2005 (see Johnson 2003, 1-2). Since 1956 there has been only two periods of positive income per capita growth in Sudan. One was during a period of peace in 1972–1983 and the other during the 1990s (World Bank 2003, 28). The economic growth in the 1970s was, nevertheless, based on foreign loans which, combined with poor governance and corruption, brought the economy to the verge of collapse in the 1980s (Amanor 1995, 887).

The growth in the 1990s seemed to have been more "real", since it has been explained by the government's economic reform programmes, absence of wide-spread droughts and, since the end of the 1990s, increased oil trade and related industries and services (World Bank 2003, 28). The growth in the 1990s has not, however, benefited the majority of Sudanese people. In fact, the government's efforts to stabilise the economy of Sudan included a drastic downsizing of the public sector. This has resulted in reduced financing for social and infrastructure services as well as poor development of civil servants' salaries. At the same time, defence and security budgets have remained high. The state and local community's expenditures have also remained a low priority for the central government. In the agricultural sector the government has favoured capital-intensive, irrigation-based agriculture, relative to traditional rainfed farming (World Bank 2003, 32-33, 40, 88).

The farmers of the study area earn their livelihood primarily from rainfed agriculture, using traditional farming practices and methods. The area is situated in

a certain "gum belt" area in Sudan (El-Dukheri 1997, 4), where gum arabic production is an important source of income for many farmers. Gum arabic is a water soluble and edible but tasteless gum that is obtained from tapping the *Acacia senega* tree. It has been used as an emulsifier, thickener, and stabiliser in food and for medical uses for more than 2000 years (Larson and Bromley 1991, 1289-1290).

In the study area, *Acacia senegal* is cultivated in farming systems with agricultural crops. The farmers practice agroforestry in which both trees and agricultural crops are deliberately cultivated (see Nair 1989, 18; Baumer 1990, 10). Trees are mainly grown in separate plots, known as gum gardens. The produced gum has to be officially traded at specific, government-controlled auctions, where either the licensed private buyers or the government-managed Gum Arabic Company (GAC) purchase the gum (Seif el Din and Zarroug 1998; World Bank 2003, 97-98).

In addition to gum arabic, sesame (*Sesamum indicum* L.), groundnut *(Arachis hypogaea* L.), *karkadeh* (*Hibiscus sabdariffa* L.) and watermelon (*Citrullus lanatus* (Thunb.)Matsumura & Nakai) are common cash crops for the farmers in the area. Watermelon is sold either as fruits or as seeds after the fruit is used for human or animal consumption. The main food crops in the area are pearl millet (*Pennisetum typhoides* (Burm.f.) Staph & C.E. Hubb.) and sorghum (*Sorghum bicolor* (L.) Moench). Livestock production is also an important part of the livelihood systems in the study area and practiced primarily by nomadic groups (El-Dukheri 1997, 22-23, 40, 75). The trade of other agricultural crops and livestock is less regulated compared to the trade of gum arabic, but is also carried out at village, regional and state levels (El-Dukheri 1997, 87).

### 4.7. Cultural setting and the people

Sudan is inhabited by a variety of ethnic groups with mixed ethnic origin, but despite the immense ethnic diversity, political and cultural division has existed particularly between the northern and the southern part of the country. The North and South differ in many ways. Most Sudanese are Muslims, who predominantly live in the northern part of the country sharing the Arabic language and Islamic culture. The population that lives in the southern part of the country includes, in turn, mainly African groups that practice either indigenous traditional beliefs or Christianity. There, Arabic is less common and the people mainly use tribal languages and some English (Embassy of the Republic of Sudan in London 2005).

During Sudan's independence, the northerners have ruled the country. Since 1989, the country has been ruled by a military regime led by General Omar El-Bashir, who

came to power with the support of the National Islamic Front (NIF), a political party whose policies have significantly been affected by Islam (Smith-Morris 1995, 878-886, de Waal 1997, 98). However, the peace agreement between the South and the North, which was signed in January 2005, states that the coalition government will be formed in Sudan including representatives from both sides. The agreement also grants autonomy for the South for the period of six years after which it can vote in a referendum whether to become independent or stay as part of Sudan (BBC 2005).

Although situated in the centre of Sudan, the study area can be perceived culturally as a part of North Sudan, for most of the people are Muslims and speak Arabic. The civil war has not had drastic, direct impacts to the sedentary farmers of the area. At the same time, indirect effects of the war, namely high financial costs, have negatively influenced public services such as those for health and education in the area. The sedentary farmers of this study included the people from a farmer village inhabited by the ethnic group of *Jawama'a*. The empirical fieldwork revealed thst some nomadic pastoralists studied had been affected by the civil war (this matter will be described more in the next chapter). The nomadic pastoralists included in this study represented several ethnic groups. The camel herders represented the *Shanable* tribe, while the cattle herders were either from the *Hawazma* group or from the *Fellata* group.

People in the area are affected by a high annual population growth, which was estimated as 2.6 percent during 1998-2000 (UNFPA 2001). The impact of the population growth on the environment has been, however, alleviated by the large-scale male-migration of sedentary farmers that has occurred in the area for decades. The men migrate outside their villages for part of the year to earn income by working elsewhere (Khogali 1991, 205; Myers et al. 1995, 13).

## 4.8. Forestry-based rehabilitation interventions

### 4.8.1. Restocking of the Gum Belt for desertification control in Northern Kordofan

The people studied have been affected by two main forestry-based rehabilitation interventions. The farmers have participated in the *Restocking of the Gum Belt for Desertification Control in Northern Kordofan* programme, implemented by the United Nations Sudano-Sahelian Office (UNSO) in co-operation with the government's forest office Forest National Cooperation (FNC). Some of the nomadic pastoralists have also participated in the *El Ain Natural Forest Management Programme*, implemented by the SOS Sahel International (UK) with the FNC.

The United Nations Sudano-Sahelian Office was established in 1973, in order to address the severe effects of the first great Sahelian drought. Under the management of UNDP, UNSO implemented a range of drought-related relief and development interventions in various Sahel countries, including Sudan. UNDP established, however, a new Drylands Development Centre to replace the former UNSO in 2002 (UNDP 2004b). The UNDP/UNSO funded project "Restocking of the Gum Belt for Desertification Control in Northern Kordofan" targeted several communities in the study area, including the study village. The intervention was implemented during 1980–1995 to address the desertification in the area by encouraging the local farmers to plant more trees.

The main activity of the programme was to provide the gum arabic producing *Acacia senegal* seedlings to the farmers in the area. During 1992–1995 farmers' associations were also established in the villages, with the aim of encouraging farmers to co-operate when selling gum arabic and other cash crops such as sesame and *karkadeh.* After donor funding ended in 1995, the FNC has continued to visit villages encouraging the people to protect and plant trees. The FNC's ability to allocate material inputs to the programme has been, however, rather limited (Ramli 2002, personal communication; see appendix 3).

### 4.8.2. El Ain Natural Forest Management Programme

An environmental intervention in which some of the nomadic pastoralists have participated, namely the El Ain Natural Forest Management Project, was implemented by the non governmental organisation (NGO) SOS Sahel International (UK) and FNC during 1989–2001. The programme started in conjunction with a the revision that was made in the Sudanese forest legislation in the form of the "Forest Act", a forest law that was published in 1989 and which included a statement acknowledging the rights of local people to manage collectively forests within their village lands (Egeimi et al. 2003, 17).

The main objective of the programme was to identify and develop ways for local people to be actively involved in the management of the forest resources. Although the programme suffered from limited funding, various activities were implemented such as the establishment of village nurseries, planting trees, digging of water catchments, training and distribution of stoves (Meadows et. al 1997; 7-25). The project mainly targeted farmers in 30 villages around the El Ain Forest Reserve, and although nomadic pastoralists were recognised as important users of the natural resources in the area, they were at first not involved with the programme.

By the end of the 1990s it became clear that the sustainability of the project was in danger due to this oversight, since when pastoralists trespassed with their animals the community-managed forest areas, conflicts between farmers and pastoralists occurred. Consequently, the project decided to tackle the conflicts with resolution activities such as negotiations between various stakeholders and group work activities that started in 1999 (Egeimi et al. 2003, 25-30). These negotiations produced also an agreement on various matters, concerning, for instance, the rights allocated to *Shanables* concerning the use of water and trees in the El Ain forest area. It, however, seems that the agreement has not been able to prevent the conflicts, owing to "outside factors" such as the government's decisions to rent common property land to private investors (UNDP 2003).

Nevertheless, some *Fellata* pastoralists also participated in tree planting activities and digging of water catchments within the project (Ali 2002, personal communication; see appendix 3). Some of them were included in this study, in order to examine whether and how their participation in an environmental rehabilitation project by outsiders has affected their environmental literacy and environmental practices.

### 4.9. Study area: Characteristics and reasons behind choosing the area

In sum, the study area is a dry (semi-arid) region, where erratic and limited precipitation has caused environmental changes. Previous scientific studies suggest that the area is not subjected to desert encroachment, nor has the overall precipitation reduced in the 20th century. It also seems that land degradation cannot be perceived as the central cause of the famines that had had occurred in the area. At the same time, the exact occurrence and even the scale of land degradation is not known. This study nevertheless assumes that severe land degradation is observable and based on the researcher's observation several sites in the study area were described as suffering from land degradation. Some efforts to rehabilitate the environment in the study area have been conducted through forestry activities. The farmers under study had been affected by a project that encouraged particularly the planting of *Acacia senegal*, while some *Fellata* pastoralists have participated in tree planting in El Ain Natural Forest Management Project.

Culturally the study area can be viewed as part of Northern Sudan, characterised by Arabic influences and the Islamic religion. Simultaneously, people with diverse ethnic origins live and move in the area earning their livelihood primarily from agriculture and animal husbandry. It is also common that male farmers migrate outside the area for part of the year to earn additional income. The two most

common production systems are sedentary farming and nomadic pastoralism including camel and cattle herding.

The study area was chosen for this study for several reasons. It was a region that outsiders had for years associated with desertification or land degradation. Thus, this study provided an opportunity to further analyse the outsiders' discussions on land degradation there and particularly, to compare these discussions with the manner that local people themselves perceive environmental changes in their home area. The forestry interventions that had been conducted in the area, also offered an opportunity to explore whether and how previously implemented environmental interventions had affected the local people, their environmental literacy and activities.

Furthermore, the area was used by both sedentary farmers and nomadic pastoralists, which allowed a study of people from these two production systems focusing on their environmental interactions. Hence, the environmental interactions of women could be studied in two groups interacting differently with the environment due to their livelihood system. Consequently, a greater diversity of views and environmental practices could be expected as compared to a situation in which solely farmer women or pastoral women would had been studied.

The study area also provided an opportunity to direct attention to the difficult situation nomadic pastoralists face there as well as in many other areas of Africa (see e.g., Casciarri 2002, 34). The chosen nomadic pastoralists included representatives from various migration patterns in the area, representing groups that passed through the area twice a year migrating frequently and groups that stayed there for several months each year. The sedentary farmers were chosen to represent a village in the area whose farmers have not only been targeted with forestry extension activities but who were also significantly involved in the gum arabic trade, so as to explore how the gum producers viewed and responded to environmental changes in the area.

Next, based on the empirical fieldwork, the results chapter presents how the farmers and nomadic pastoralists interacted with their environment to maintain their livelihood in the study area and which factors affected their land use decisions there. Moreover, it describes how they perceived environmental changes in the area and the idea of addressing these changes with environmental rehabilitation. First, the information collected on nomadic pastoralists is presented, after which the information on farmers follows.

# 5. Results

## 5.1. Nomadic pastoralists: Ethnic background, age structure and migration patterns

### 5.1.1. Camel pastoralists

The results that will be presented in this chapter are based on the fieldwork that included 42 individually-interviewed the nomadic pastoralists and 40 farmers. Moreover, the researcher observed the environment, discussed with key-informants and interviewed nomadic pastoralists and farmers in group discussions, sometimes also applying PRA methods. The researcher chose the individually-interviewed pastoralists randomly, at the same time ensuring that approximately half of the pastoralists would be women and half men representing various ages. The study included two main groups, namely the nomadic pastoralists that earned their main livelihood from camels *(*known as *Abbala*) and the pastoralists that earned their main livelihood from cattle (known as *Baqqara)*. Table 1 summarises the age structure and the sex division of the individually interviewed camel pastoralists.

Table 1. Background information on the individually interviewed camel pastoralists[4]

| Sex | Number of interviewees by age group | | | |
|---|---|---|---|---|
| | 17-30 years | 30-50 years | 50-70 years | Total |
| Women | 5 | 5 | | 10 |
| Men | 2 | 6 | 2 | 10 |
| Total | 7 | 11 | 2 | 20 |

All the camel pastoralists in this study represented the *Shanable* ethnic group, including pastoralists with various migration patterns. Although many former nomadic cattle and camel pastoralists had also become sedentary farmers in the area, this study included solely those pastoralists who still moved their homes at

[4] When reading the table above, note that both the camel and cattle-herding pastoralists expressed rather commonly that they were uncertain about their age. A few women even stated that they were not able to estimate their age at all and consequently, the researcher estimated the age of these pastoralists with the help of her research assistant.

least a few times during the course of the year. The researcher collected the information on migration routes and reasons behind certain migration patterns mainly by interviewing groups of women and men belonging to divergent pastoral groups. Moreover, she also asked about migration separately in some individual interviews.

Altogether, the study identified three divergent types of *Shanable* groups with differing migration patterns. Firstly, there existed the traditionally migrating *Shanables* in which two divergent groups that moved separately were identified. The *Shanables* who still followed the traditional migration pattern entered the study area from the South-East continuing to the North-West and then returned through the area. The return through the study area took place in the rainy season, around July-October, during which time they were interviewed for this study. These two communities passed through the area twice a year moving once in 1-10 days, depending mainly on the availability of vegetation for camels and other animals. The study included 12 of these frequently-moving nomadic pastoralists who represented nearly one-third of all the interviewed nomadic pastoralists.

Secondly, the study identified a *Shanable* community in which predominantly young, single men still herded camels following the old, long routes. The others in this community moved less frequently and in a smaller area and stayed in the study area most of the year. In addition to camels, many families of this community had bought cattle and received income from selling cow milk to El Obeid; some of the families also cultivated occasionally. The third *Shanable* group moved only three times a year, residing mainly in the study area. The most important source of livelihood for them was cultivation. Some of the households still had a few camels left, but the majority had lost their camels. This group was the poorest of the *Shanables* in the area, who had not been able to invest in new camels or to buy cattle.

In terms of environmental impact of the livelihood activities, the migration pattern played an important role for two reasons. Those pastoralists, who spent more time in the study area than before, had naturally increased their environmental impact on the area. The environmental impact was particularly significant if a household herded many animals. The camel-herding households reported considerable differences in the number of animals (0-100 camels were reported per household). Hence, the animal-related environmental impact of divergent pastoral households varied considerably. *Shanables* also kept commonly goats and sheep; a few families also kept donkeys for transporting purposes (mainly to carry water). The number of small ruminants was significant; in half of the interviewed households, the number of sheep and goats was more than 10 and several families owned over 50 small

ruminants. The family that had the most goats and sheep was estimated to own approximately 140 heads altogether.

In addition to the impact of animals, the modifications made in traditional migration had in some households led to cultivation activities in the study area, and therefore, increased the land taken for private use. In this way the nomadic pastoralists had participated in the increased privatisation of land in the area, adding pressure on the natural resources on reduced common property land. The *Shanables* had modified their migration patterns and livelihood strategies during recent decades for multiple and intertwined reasons. The great drought in the first half of the 1980s and the drought at the beginning of the 1990s (see Figures 4 and 5 in chapter 4.4.1) had affected many camels due to reduced water resources and vegetation, resulting either direct deaths of camels or deaths after they had been weakened by illnesses. The reduction of the number of camels had impoverished the pastoralists, and many families had been obliged to gradually eat the rest of their camels. Furthermore, as raised in chapter 4.5, the herding of camels and other animals by the pastoralists had become increasingly difficult due to the privatisation of land leading to the decrease of common property land. Scarcity of land had also triggered conflicts between *Shanables* and local farmers, when camels and other animals had entered agricultural land of farmers to eat agricultural crops and the gum producing *Acacia senegal* trees.

These conflicts over land use were discussed particularly with men in some of the interviews with questions added to the "basic" list of what was asked. These interviews disclosed that the conflicts had sometimes developed into violent confrontations, although in most cases the pastoralists and farmers had resolved them peacefully. Normally, farmers first captured the animals found in their agricultural land and returned them after the pastoralists had paid them a fee to compensate for the destruction in the fields. Negotiations of the fee were conducted either directly between the farmers and the pastoralists or if it could not be resolved, by the tribal leaders (*sheiks*) from both groups. Sometimes the *sheiks* of farmer villages also appointed a separate farmer committee to help them to estimate the sum that was asked of nomadic pastoralists for the damage that had taken place on the farms. The *Shanables* (and the cattle pastoralists) preferred, however, to settle the conflicts directly with the farmers, for they believed that the farmer committees had a tendency to suggest high compensation fees.

Hence, negative developments in the pastoralists' circumstances such as insufficient precipitation increased the poverty, and scarcity of land available for pasture had affected camel pastoralists' decisions to modify their migration and livelihood strategies. But even so, there were also some pastoralists who perceived some positive aspects in the changed lifestyle that included less frequent migration. These

pastoralists described the current way of life as “more comfortable” and were representatives of wealthy *Shanable* households who had been able to adapt to the circumstances of the study area successfully. These households had been able to combine camel and cattle husbandry, which enabled them to benefit economically from the large market for cow’s milk in El Obeid.

### 5.1.2. Cattle pastoralists

The cattle pastoralists included two ethnic groups, namely *Hawazma* and *Fellata* pastoralists. Table 2 presents the age and sex division of the individually-interviewed cattle pastoralists. Tables 1 and 2 confirm that nomadic pastoralists from various ages participated in this study, although all pastoralists were over 17 years of age.

Table 2. Background information on the individually interviewed cattle pastoralists

| Sex | Number of interviewees by age group | | | | |
|---|---|---|---|---|---|
| | 17-30 yrs | 30-50 yrs | 50-70 yrs | over 70 yrs | Total |
| Women | 2 | 5 | 4 | 1 | 12 |
| Men | 2 | 5 | 3 | | 10 |
| Total | 4 | 10 | 7 | 1 | 22 |

Similarly to the *Shanable* camel herders, also the *Hawazma* cattle pastoralists had traditionally moved seasonally and regularly, but following a route from South to North and back so that the study area was located at the northern end of their migratory route. They entered the area during the rainy season to escape from mud and insects that increase during the rains in the South and stayed in the El Obeid area 2-3 months every year. After the rains they returned to the South. During recent decades, many *Hawazmas* had, however, changed their migration patterns.

This study included representatives from two *Hawazma* communities, who had both changed their traditional migration patterns and now stayed during the course of the year mainly in the study area moving their villages 3-4 times a year. A few of these households also owned land in the south of the study area which was either cultivated by their relatives or rented out to other people. The *Hawazmas* earned their livelihood most of all from selling cow’s milk to El Obeid. They took the milk

to a tarmac road that connected El Obeid to Khartoum. The middle men arrived with cars, bought the milk and transported it to El Obeid.
As a whole, the *Hawazmas* described most often the milk trade as the main reason why they preferred to move primarily in the study area. Other positive aspects of the area included the availability of water for animals and people in the wells and *hafirs* excavated in the area as well as the availability of medical services for children. Some *Hawazmas* also made a point that migration was not very tiresome anymore, for several families together could rent a truck from El Obeid when they moved to a new place. At the same time, the reasons given for the *Hawazmas* 'decisions for not to return to the South were not only connected to the positive aspects of the study area; the civil war that had been going on in the South was also stated in some interviews as one of the reasons why the *Hawazmas* preferred not to move there anymore.

The cattle pastoralists that belonged to the *Fellata* ethnic group were originally from western Africa but had lived and moved in the study area for several generations. The study included a *Fellata* community that lived relatively close to the El Ain forest reserve during the time of the interviews. Of all of the pastoral communities included in this study, this community was the only one that had previously planted trees in the outsiders' forestry intervention project (El Ain Natural Forest Programme; see chapter 4.8.2) in the study area. This participation was the main reason why the *Fellatas* were included in this study, so that the possible impact of this intervention on the environmental literacy and behaviour of the pastoralists could be assessed.

The *Fellatas* had lived and moved in the study area all their lives. The community had previously moved in the area as part of a larger migration route, but around the mid-1980s, after the great drought, the route was permanently changed and shortened. The community moved approximately four times a year. They moved mostly in North Kordofan, near El Obeid, although sometimes they moved also to the south of the study area, if the precipitation had been limited. Cultivation was common in this community, but the agricultural plots were mostly so small that very little or no income could be earned by selling the harvest from these crops. They nevertheless had cropland that had belonged to them for generations, and the land was therefore perceived as "inherited", rather than rented each year.

The cattle herding *Fellatas* and *Hawazmas* had also had conflicts with the sedentary farmers over land that had been tackled in a similar way as in the case of *Shanables* and farmers. In addition to cattle, the *Hawazma* and *Fellata* households commonly kept other animals such as sheep and goats; donkeys were also kept for transportation purposes (to carry water and firewood). Similar to the *Shanable* households that owned an extremely variable number of camels, also the *Fellata* and

*Hawazma* households owned a varying number of cattle. The number of small ruminants was also rather high; approximately one-third of the households reported owning over 10 heads of goats and/or sheep, and the households that owned the highest number of small ruminants reported 100 animals.

Thus, the trading possibilities in El Obeid had attracted the cattle pastoralists to change their migration patters and to move predominantly in the study area during the course of a year. Moreover, the availability of water for animals and people and the availability of medical services for children were described in interviews as the reasons that had attracted the cattle pastoralists to move particularly to the study area. Some pastoralists also reported that the civil war had affected their decision not to migrate to the South of the study area anymore.

## 5.2. Economic, political and cultural factors affecting environmental activities among pastoralist women

### 5.2.1. Economic resources and their distribution

The nomadic pastoralists under study moved in an area that included places with visible degradation. As described in chapter 4.2, one such degraded area was a zone several kilometres' wide around El Obeid, an important urban centre where a great number of camels, cattle and small ruminants were traded. Consequently, large herds of animals were moved in and out of the town, although the El Obeid-Khartoum tarmac road also facilitated transporting of animals with trucks and pick-ups. Nevertheless, the environmental impact of the animals was observable around El Obeid, including extremely scarce vegetation and trampled ground around the town. Further away from the town, the animal impact was particularly important around the *hafirs* that had been used by domestic animals.

Photo: Anu Eskonheimo

Figure 6. A *hafir*

Thus, domestic animals seemed to cause land degradation in the study area and since the pastoral men were mainly in charge of animal management, they also played a more significant role in this animal-related degradation compared to the women. However, the environmental impact of the activities of divergent pastoral households varied, since the impact of households also depended on the number of their animals and the length of time their animals stayed in the study area. It needs to be also emphasised that the men decided about the migration patterns and livelihood strategies of their households in circumstances that included factors over which they had no control. For example, the civil war and droughts had "pushed" the pastoralists to modify their livelihood strategies and the large market for cow milk in El Obeid had attracted pastoralists into the area.

Hence, although the pastoral men decided in the families on migration and husbandry, their decisions were made in certain biophysical and social circumstances that conditioned their decision-making. Nevertheless, since the size of herds in pastoral households was an important factor that affected their impact on the environment in the area, efforts to study households' economic resources or assets were made. Detailed research on the material assets proved to be, however, a rather complicated task. In the beginning, both some camel and cattle-keeping

pastoralists were asked to estimate their yearly household income, but it became clear that this was a problematic question. The women expressed difficulties at estimating the animal-related income, since the men were in charge of the animal trade and the income tended to fluctuate without systematic yearly patterns. The unsystematic pattern of receiving income from animals was also mentioned by some men as a reason for difficulties to give estimations of their yearly household income. When asked particularly about the income in the previous year, some men gave estimates.

In general, the income-related questions seemed difficult for the pastoralists. Therefore, the approach was slightly modified and the material household resources were studied simply by inquiring about the number of animals each household had and about their other material resources and sources of income (see the questions in appendix 1). Unfortunately, even these types of questions seemed problematic. An important reason was perhaps was that the researcher moved in the area with cars that belonged to the government forest department FNC (Forests National Corporation) and hence, although working as an independent researcher, became perhaps associated with the government (although she made efforts to emphasise her independent status). Some government officials, in turn, had earlier approached the pastoralists in order to collect taxes. Therefore, it is possible that the pastoralists were concerned that revealing to the researcher income-related information might cause them extra expenses later on. This issue was pointed out to the researcher by a key informant, an employee of the FNC who had worked over ten years in the area. It is thus possible that since the researcher was associated with the government, at least some of the pastoralists may have downplayed the number of animals in their households rather than overestimated the numbers.

The study included mostly pastoralists who each represented a household with the exception of two households represented by both the head of household and his wife. In these interviews, the women estimated their household to own fewer animals as compared to the men. Since the men were mainly in charge of the animals, it was natural that they had more accurate knowledge of the numbers of animals. This was demonstrated particularly in the interviews of three *Baqqara* women, who stated that they were not able to estimate the number of their cattle at all.

For these reasons, the information received on material assets or resources of the pastoralists cannot be assumed to provide exact data of the domestic animals and the land the various pastoralist households owned. Nonetheless, it is believed here that based on available information, the nomadic pastoralists can be divided roughly into three categories, hoping that this will give *a rough idea* of the economic situation

among them. The developed categories of "poorest households", "middle income households" and "wealthiest households" are solely based on the situation of the nomadic pastoralists studied. Hence, it is not assumed that for instance a "middle income household" would represent medium standard of living in the study area (or in Sudan in general).

The researcher received information from 37 households concerning their animals and agricultural land. Households grouped in the ”poorest households” category owned no camels or cows at all and cultivated a maximum of 3.7 hectares of agricultural land. The other extreme category of the "wealthiest pastoralists" included households that owned 50-300 camels and/or cows and these families also had the largest herds of goats and sheep. Furthermore, a household who owned fewer animals but had 126 hectares of agricultural land in the South (that they have rented out) was also included in the category of the “wealthiest pastoralists”.

Households in the third, "medium status" category owned 10-50 animals that in most households included both camels or cows and small ruminants. Nine of these "medium status" households also cultivated in the study area, but excluding the *Fellatas* who had inherited land, the plots were rented (with one exception of purchased land). The agricultural plots were also small (1.5-7.4 hectares with one exceptional *Fellata* household owning 36.8 hectares). The average size of a pastoral household was 6.5 persons. No clear connection was found between family size and wealth: the wealthiest families did not necessarily include many people, nor were the poor families always small.

Although the government officially owned all the land in the study area, the croplands were perceived to belong to the local farming communities according to the traditional land tenure regime. Hence, local farmers perceived that the land that was “inherited” or “bought” from other local people really belonged to them. The nomadic pastoralists had mostly rented their cropland, which was rented either from *sheiks* of farmer villages or from farmers. Table 3 presents information on nomadic pastoralists’ material resources or wealth at the time of the interviews.

Table 3. Characterisation of the economic status of pastoralist households at the time of interviews (total 37 households)

| Characterisation by household category | | |
|---|---|---|
| Poorest households (4) | Middle income households (28) | Wealthiest households (5) |
| - No cattle or camels at all<br>- Less than 10 sheep and/or goats<br>- Maximum 3.7 ha of rented or (rarely) owned agricultural land | - 10-50 cows or camels<br>- Combined with 1.5-36.8 ha of rented or owned agricultural land | - 50-300 camels and/or cattle<br>-Often combined with large herds of goats and sheep |

It must be noted, however, that in addition to the animals and agricultural land, the households also had some other sources of income, which was important especially for the poorest households. This income was often provided by women who made handicrafts such as grass mats for sale and were involved in small trading activities such as selling daily necessities (sugar, tea etc.). Some poorest women and men also traded firewood for additional income – an issue that will be discussed later in this chapter.

Thus, the nomadic pastoralists included households with variable numbers of animals and migration strategies resulting in differing periods of time spent in the study area and variable environmental impacts. The men decided on migration and livelihood strategies, but their options were regulated by the contextual factors such as climate and economic circumstances.

### 5.2.2. Culture, politics and the role of pastoralist women in decision-making

From a cultural point of view, the pastoralists were affected by a gender ideology that perceived the men as the natural leaders, decision-makers and providers in the families. Women, in turn, were in charge of domestic duties such as cooking and child care. Women's role in agriculture was perceived as complementary. In husbandry, they were seen suitable for assisting the men in milking, tending of sick and young animals and looking after small animals such as goats and chickens. In crop-cultivating households, the women's role was normally to assist the men in the fields, although in some households women did not participate in cultivation at all. The interviews also confirmed that among the nomadic pastoralists, a woman was

not perceived suitable as a head of a household; if a pastoral woman became widowed, her male relatives were expected to take care of her.

Gender was reflected in the use of power at the household and community level. According to group interviews, the men discussed and decided upon community matters. In villages, the *sheikhs* were considered as the main leaders of the communities, but also older men ("elders") were consulted over many communal matters. Men and older men in particular, possessed the main authority and power at the family and household level, while the youngest women had the least power. The issue of decision-making power in families, was discussed in all the individual interviews (see the questions in appendix 1.), particularly concentrating on the power over livelihood-related decisions, including mainly modifications in migration patterns and animal trade. These discussions disclosed that particularly recently married young women lived rather commonly in households that were headed by their husbands' fathers. This group of women had practically no power at all over family matters, including economic matters. Furthermore, there existed another group of women with extremely limited power in the families; the second wives, who were expected to obey both the husband and the first wife.

The other pastoralist women formed a more diverse group. The majority of this group, including first wives, mothers and sisters of household heads, had participated in the economic decision-making by discussing with household heads and stating their opinions. This situation was described to the researcher by both the interviewed women and the men. Thus, at least some of the women also affected the decisions made about selling animals or modifying the migration routes and livelihood strategies. The influence of women on the decisions was assumed to depend on the particular power dynamics in each household (it would have required deeper studies of the households to present a more detailed analysis of the women's power in the decision-making). Nevertheless, the discussions with pastoralists suggested that the majority of women had participated in economic decision-making somehow, but *men still held the final decision-making power in economic matters.*

### 5.2.3. Livelihood activities of pastoralist women

Although the men were the main economic decision-makers and animal managers, also women conducted activities that affected the environment in the study area. The most important activity was the collection of firewood, since a regular firewood supply was needed for cooking. Most households had a charcoal stove, but only the wealthiest families could regularly buy charcoal. Thus, the women mainly burned

the firewood on an uncovered three-stone stove, where the wind affected strongly the burning of branches.

The firewood collection activities were studied in more detail through observation as well as by questions added to the "basic list" of questions in some individual interviews and group interviews with women. The interviews disclosed that collecting firewood was a burdensome task particularly for the *Hawazma* and the *Fellata* women, who stayed in areas with the scarcest vegetation. These women spent daily approximately 1.5-2 hours looking for firewood, if no donkey was available for the task. When using a donkey, the women could gather more firewood and transport it at one go; this firewood would last for cooking approximately 2-3 days. Firewood collection was generally less of a burden for the *Shanable* women in traditionally migrating communities who tended to live closer to woodlands and forests which the camels needed for browsing.

Normally, the various pastoral women broke the twigs with their hands and thus used no tools such as axes to cut trees to obtain wood for their own cooking purposes. They preferred "dry wood" (dried parts of trees or dead trees), because such wood was easy to collect on the ground or from a tree and it burned well. Straight branches without thorns were also liked, although some of the women also stated that they just collected wood without selection. Nevertheless, when the environmental impact of this firewood collection is estimated, it needs to be acknowledged that thick branches were not cut and the stems of the trees were not harmed.

Figure 7 illustrates the type of firewood pastoralist women selected for their own use. The environmental impact of the firewood collection by pastoral women was thus reduced by the manner in which the wood was collected. The families needed, nonetheless, a steady supply of firewood for cooking and the breaking of branches might have affected already weakened trees. If the firewood collection by women had been the last factor that finally killed a tree in an already degraded area with particularly scattered vegetation and perhaps also used by a large number of animals trampling the soil, the collection of firewood for cooking could perhaps be seen as one of many factors that had contributed to the land degradation. In other words, firewood collection for private use perhaps contributed to land degradation in such areas, where the environment was already strained by several other factors. The poorest pastoral women were also forced to cut firewood for sale, in order to maintain their livelihood in the area. The trade of fuelwood had resulted in intensive cutting of trees, where axes were used and even tree trunks cut. Therefore, it seemed that poverty had caused the most intense fuel wood cutting among the pastoral women.

Photo: Anu Eskonheimo
Figure 7. A pile of firewood for cooking.

Women used also trees for building and carpentry activities, which were discussed with some additional questions in some individual interviews. The *Shanable* women and girls were in charge of building shelters using materials such as wooden poles, ropes, camel skins and grass mats (see Figure 8). The *Hawazma* and the *Fellata* women built their round huts with grass mats, wooden poles, cloth and plastic sheets (Figure 8). Women used the wooden poles for building as long as they lasted, and the most durable poles were bought from markets. Some pastoralist women also made furniture (particularly beds) from wood, but the scale of this activity had been reduced according to the pastoralists, and the researcher also commonly observed iron beds in the pastoralists' homes.

The involvement of the pastoralists in the monetary economy and an ongoing commoditisation were also demonstrated in the use of other household items such as metal pots or plates that were bought rather than hand-made. To some extent, the women had thus affected the environment in the study area as builders and carpenters, although it was impossible to estimate the exact environmental impact of these activities. The building poles were naturally a necessity, but since they were used as long as they lasted and since particularly long-lasting poles were bought from markets, the impact of building was reduced. Moreover, the scale of the own carpentry activities of the pastoralist women seemed to have been reduced over the years and was already limited during the time of the research.

Photo: Anu Eskonheimo

Figure 8. *Shanable* women setting up a shelter.

Photo: Anu Eskonheimo

Figure 9. A *Hawazma* hut

Finally, a livelihood activity that had affected the environment in the study area was the crop cultivation among the pastoralists. In this study, of the randomly chosen 40 pastoral households (represented by 42 pastoralists), 13 cultivated the land during the time of the fieldwork. The agricultural plots were mostly on the *gardud* soil (excluding three households which cultivated on *qoz* soil) that existed South of El Obeid. The land was predominantly rented for varying periods of time with an exception of the *Fellata* households which had inherited their lands from their parents. The most important crop for livelihood was sorghum (*Sorghum bicolor*), which was the main food crop. Sesame (*Sesamum indicum*) was another important crop for the pastoralists, who commonly rotated these two crops on the same plot to increase the productivity. Other cultivated crops included groundnut (*Arachis hypogaea*), okra (*Hibiscus esculentus* L.), hibiscus (*Hibiscus sabdariffa)*, watermelon (*Citrullus lanatus*) and pearl millet *(Pennisetum typhoides*).

Some households used tractors to prepare the *gardud* land, but not the majority. Some also burned the land prior to cultivation. The interviewed pastoralists had not purposefully added animal manure or any other fertilisers to their croplands, but it is possible that the migration of animals in the area nevertheless fertilised much of these croplands. Trees were found on their croplands, but in low quantities only and perceived solely as shade trees for people. A few pastoralists had also deliberately cut all the trees on their farms, since they believed that trees would attract birds to the fields, which would eat the seeds of their crops.

Pastoralists who mainly rented their land had not been able to apply a cultivation system with long fallow periods. Whether and to what extent this practice had affected the land, cannot be known without further soil analysis. However, it seems likely that at least some cropland degradation had taken place owing to the relatively intensive cultivation methods that excluded long fallow periods. From the perspective of the study area as a whole, the environmental impact of these farming activities would be, nonetheless, relatively limited. This was the case, because only minority of the pastoral households cultivated the land and they generally occupied small plots and thus allocated only a limited land area for such farming activities. The crop-cultivating pastoralist women conducted mostly sowing, weeding and harvesting activities, thus assisting the men in the fields.

Hence, the pastoralist men clearly had the main decision-making power over the use of agricultural land, when the women affected the environment mostly by collecting firewood. Collection of firewood for private use had, however, limited environmental impacts due to the collection methods. Mostly, the environment was affected by the poorest women, who collected fuelwood for sale. Next, it is disclosed that the environmental impact of this trade was also brought up by pastoralists

themselves, although they stressed that the environmental changes in the study area were most of all caused by fluctuating precipitation.

## 5.3. Literacy in environmental changes among nomadic pastoralists

### 5.3.1. Occurrence of the changes according to nomadic pastoralists

Conceptions of the environment in the study area by the pastoralists were in this study seen as a particular important study topic in order to acquire knowledge of the environmental changes in the study area and of the roles of the pastoralists in these changes as well as of their views on environmental protection and rehabilitation activities. When exploring particularly which types of changes the pastoralists perceived to have occurred in the area, they were first asked whether they thought that the environment surrounding them had changed during their life time. Additionally, if needed, the researcher also asked separately the pastoralists to describe the types of changes they had observed in the area. A great majority of them (38 of the total of 42 pastoralists interviewed) stated that changes had taken place and they commonly immediately described the changes. The most commonly described change was that of a *reduced number of trees*, which was described in 37 interviews. The majority described a drastic change:

*"This was a forest in the past, now it is a desert..."*
*Woman, 30 years old.*

*"There was a forest here in the past. Now many, many trees have disappeared... "*
*Man, 20 years old.*

*"The time of trees is finished."*
*Man, 40 years old.*

Since the nomadic pastoralists commonly emphasised that there were fewer trees in the area, this topic was further discussed in approximately half of the interviews. In these interviews, the researcher inquired separately, whether any tree species had become extinct in the study area and if so, whether the pastoralists could give examples of tree species that had vanished. The lists of extinct trees species varied quite a lot, which might have reflected a situation where a large number of species had reduced from the pastoralists' living areas. Nonetheless, there were four tree species that were listed as locally extinct in more than one-third of these interviews, both amongst women and men. These tree species were *kitir* (*Acacia mellifera (*Vahl)

Benth.), *gudim (Grewia tenax (*Forssk.*)* Fiori*), andarab (Cordia sinensis* Lam.*) and shutah (Combretum* spp.*).*[5]

In addition to the reduction in the number and species of trees, the quality of the trees was also said to have been decreased due to the locusts which had foraged on their leaves. In addition, a pastoralist man described that the disappearance of trees in a certain place in the study area was due to the former usage of that land for mechanised agricultural crop production. He described that this area lacked trees, because "no tree seeds have been left in the ground". He was also the only pastoralist who described cropland degradation in the area, saying that a commercial farmer who had established the mechanised farm had abandoned it as a result of its decreased productivity (this site was earlier shown in Figure 8 with a *Hawazma* hut).

At the same time, none of the nomadic pastoralists described a decrease in production of the agricultural lands that they themselves had cultivated. Since many pastoralists had rented their croplands and started the cultivation rather recently, many did not have long-term experience of cultivating the same land, and perhaps at least partly for this reason they did not bring up the issue of reduced cropland productivity in the interviews. However, also the *Fellatas,* who had cultivated the same lands for years in the study area, did not describe their cropland as degraded.

Moreover, particularly the cattle pastoralists commonly reported that in addition to trees, also grasses have diminished in the study area. A pastoralist woman described that the agricultural crops of her household had diminished due to insects which destroyed them. Two men also explained environmental changes in a way that indicated gender specific environmental literacy, related to the gender-based division of tasks and the men's role in livestock management. One of them had observed that a new, dangerous plant that had killed goats had emerged near the *hafirs* in the study area. Another man told that there is a new, harmful plant in the area that damages the udders of cows. Furthermore, in addition to changes in vegetation, some other environmental changes were also described such as that is was windier than before. A man also believed that the number of mosquitoes had increased in the vicinity of the El Obeid – Khartoum tarmac road.

Nevertheless, although a great majority of the pastoralists described environmental changes in the area, there was also a small group of pastoralists who did not discuss the changes in this study. This group included four persons, a young man and three

[5] Dr. Mohamed El Mukthar Ballal, Dr. Abdalla Gaafar Mohamed and Mr. Salih E.E. Elagab (see appendix 3) assisted the researcher in connecting the Arabic tree names to the scientific names.

young women. Three persons in this group were relatively new to the area. The pastoralist man had lived in the area only during the past two years and had not observed any changes during that time. He was not responsible for herding, but earned income by teaching at a religious school and was the only literate person among all the pastoralists that participated in this study. Added to this, the effect of gender became apparent in the environmental literacy of two women. These women had moved into the area recently, because they had been married into communities that lived in the area and therefore they could not describe any environmental changes.

The third pastoralist woman, however, had lived and moved in the area all of her life, but it was still difficult for her to describe any changes in the environment. Naturally, the reasons behind these difficulties could only be speculated, but some suggestions of the reasons are presented here to demonstrate the complications the research on environmental literacy may face. The interview of this pastoralist woman took place in a situation where the researcher visited her community for the first time and rather shortly after she had been introduced in the community, she started to interview the woman. The interviewee was now rather suddenly in a new situation with a foreign, strange person in front of her. Generally, the pastoralist women studied were not accustomed to interact with people outside their communities, and even in the communities and the families the youngest women had the least visibility and the power to express their opinions. It is therefore possible, that the oddness of the situation might have intimidated the interviewee.

Another element that might also have caused complications also, was that she was asked to describe environmental changes verbally, which might have felt odd for the respondent who was accustomed using the environment, rather than discussing it. This “practical” relationship with the environment perhaps affected many other interviews as well – it was not easy for the interviewees to sum up in some sentences the vast amount of information they had accumulated during daily interaction with the environment and with other people. The nomadic pastoralists and farmers also tended to emphasise what the environmental changes meant for their livelihood. Hence, it seemed that it was rather "theoretical" for many of them to discuss the changes as such. What really mattered most and what they were most eager to discuss was *what the environmental changes meant for their livelihoods and economic situations*.

Particularly when interviewing women, an issue that often also needs to be tackled in field work is their domestic work load. This was perhaps also demonstrated in the example of the young pastoral woman above, who obviously was familiar with the area but still unable to describe its environmental changes. She had difficulties to

concentrate on the interview because of her small baby who frequently distracted her and demanded attention. As a result, the interview situation became visibly stressful for her and the researcher finished the interview rather quickly without asking more about the environmental changes or asking about the changes in a different way.

Nevertheless, this interview was presented here in order to demonstrate the complications that may sometimes emerge in the interviews in which environmental literacy is researched, which also affects the research material or data that is collected. Therefore, if verbal expressions are used as a source of information on local environmental literacy, it seems worthwhile to combine them with other sources of information such as observing and participating in people's daily activities. Table 4 summarises the literacy of environmental changes that was identified in individual interviews with nomadic pastoralists.

Table 4. Environmental changes as described by nomadic pastoralists
(N = 42; 22 women and 20 men)

| Environmental change | Number of interviews in which the change was described | | |
|---|---|---|---|
| | Women | Men | Total |
| There is less vegetation (particularly trees ) | 19 | 19 | 38 |
| It is windier than before | 5 | | 5 |
| Trees are of lower quality | 2 | 1 | 3 |
| Crops are damaged by insects | 1 | | 1 |
| Tree seeds have disappeared | | 1 | 1 |
| The productivity of cropland has decreased | | 1 | 1 |
| A new plant that harms cattle has emerged | | 1 | 1 |
| A new plant that kills goats has emerged | | 1 | 1 |
| There are more mosquitoes by the tarmac road | | 1 | 1 |

### 5.3.2. Conceptions of reasons behind environmental changes among pastoralists

The nomadic pastoralists who had not described environmental changes in the area did not naturally discuss reasons behind such changes, either. Others discussed the reasons, either when describing the changes or after the researcher had asked about them separately. In all of the interviews in which environmental changes were discussed, two reasons behind the changes were suggested: namely, the reduced precipitation identified as the main reason and intensive cutting of trees.

The intensive cutting of trees proved to be a rather sensitive topic for the pastoralists, who commonly discussed the topic briefly. Approximately half of the pastoralists did not specify exactly who the tree cutters were or why the trees had been cut so intensively. The other half of the pastoralists who disclosed more information about tree cutting connected it with farmers felling trees to acquire land for crops or with the firewood and charcoal trade. The trade in woodfuels that seemed to occur without required government's permission had obviously reached a rather significant scale in the study area, as the researcher could several times observe firewood traders standing beside of piles of chopped wood by the Khartoum – El Obeid tarmac road.

Most of the pastoralists who had suggested the firewood trade as the main reason behind too intensive cutting of trees in the study area did not suggest exactly who the cutters were, but referred to them generally as "people" or "poor people". Those pastoralists, who did name the actual fuelwood traders, mostly mentioned farmers. Some pastoralists were, however, involved in this trade, which seems to explain why the topic was not discussed freely. In two interviews it was, nonetheless, disclosed that also pastoralists had been involved with this livelihood activity:

*"... we are obliged to cut, if there is no work available and no animals."*
*Woman, 38 years old.*

*"Here we cut for firewood and charcoal. The trees are cut until you see the root".*
*Woman, 50 years old.*

Normally, a same pastoralist suggested only one reason behind the too intensive cutting of trees that was usually the fuel wood trade. In addition to the fuel wood trade, the most commonly-mentioned activity was the felling of trees by farmers in order to clear land for agriculture, which was mentioned in more than one-third of the interviews. Added to this, three pastoralists described that the foreign-owned

*Malaysian African Asian Company* had affected the tree cover by cutting all the existing tree species in their plantation area and by planting the gum arabic-producing *hashab (Acacia senegal*) tree instead. A pastoralist man also claimed that the forest service FNC had cut trees in the area in order to generate income. The logging activities by the FNC in the El Ain forest were also introduced to the researcher by the FNC staff. The logging activities were limited to a rather small area during the time of the interviews, but the scale of the previous logging did not become clear. Some pastoralists mentioned also other reasons behind the environmental changes in the study area than solely limited precipitation and too intensive cutting of trees. Two women stated that the wind was responsible for the damaged trees in the area. Two women and a man also described that locusts had damaged trees in the study area and a women explained that "several insects" had lately foraged on and damaged crops in the area. The harmful environmental impact of the pastoralists' own livelihood activities of herding animals and collecting firewood for cooking were brought up only in two interviews.

Table 5. Reasons behind environmental changes according to nomadic pastoralists (N=42; 22 women and 20 men)

| Reasons behind changes | Number of interviews in which the change was described | | |
|---|---|---|---|
| | Women | Men | Total |
| Reduced precipitation | 19 | 19 | 38 |
| Cutting of trees | 19 | 19 | 38 |
| Locusts that eat trees | 2 | 1 | 3 |
| Winds that destroy trees | 2 | | 2 |
| Insects that eat crops | 1 | | 1 |
| Animals that destroy vegetation | | 1 | 1 |

Table 6. Reasons behind intensive cutting of trees according to nomadic pastoralists (N=42; 22 women and 20 men)

| Reasons behind intensive cutting | Number of interviews in which the reason was mentioned | | |
|---|---|---|---|
| Suggested reason | Women | Men | Total |
| (Poor) people are obliged to cut in order to sell fuel wood | 10 | 6 | 16 |
| Farmers have cleared land for cultivation | 6 | 9 | 15 |
| Farmers cut trees in order to sell fuel wood | 2 | 3 | 5 |
| Malaysian African Asian company has removed trees | 1 | 2 | 3 |
| Pastoralists have cut trees in order to sell fuel wood | 2 | | 2 |
| FNC has cut trees to earn money | | 1 | 1 |
| People have cut trees for domestic firewood use | | 1 | 1 |

In sum, the divergent nomadic pastoralists expressed rather similar perceptions of environmental changes. In all of the interviews in which changes were discussed, the pastoralists reported that the vegetation cover of the area had clearly decreased. All these pastoralists suggested two reasons for this, namely the reduced precipitation and the too intensive cutting of trees, emphasising particularly the significance of precipitation in environmental changes.

The most commonly-described reason behind too intensive cutting was the fuelwood trade, although also the felling of trees to clear land for agricultural production was rather commonly described. Pastoralists seldom specified who the cutters for the fuel wood trade exactly were. The trade was, however, usually connected with poor families. At the same time, the pastoralists' own livelihood activities of animal herding and cutting of trees for domestic firewood were rarely mentioned to affect the environment in the area.

The interviews did not disclose clear differences in how women and men perceived the environmental changes. In fact, only in two answers by young women could the effect of gender be seen clearly, for they had been only recently married into the local communities and were consequently not able describe environmental changes over the years. Two men also described such changes in the environment that might have reflected the gender-based tasks of pastoral men in livestock herding and their greater mobility as compared to women.

## 5.4. Conceptions of environmental rehabilitation among nomadic pastoralists

### 5.4.1. Perceptions of the role of people in addressing environmental changes

The literacy in environmental rehabilitation was studied among the nomadic pastoralists by inquiring whether the pastoralists believed that there was anything that they could do to address the environmental changes in the area around them and if so, what they believed could be done. Particularly the women answered these questions by commonly doubting the power of humans to address the environmental changes at all. The women continued to stress that precipitation played a key role in environmental changes in the study area, often mentioning God as the only power that can affect rain:

*"There are no ways. We can only pray to God to give us rainfall."*
*Woman, 30 years old.*

*"We can only go to the sheikh and ask him to pray for us."*
*Woman, 25 years old.*

Simultaneously, the majority of men and almost half of the women suggested measures that could be conducted in order to address environmental changes. The most commonly suggested measure was to protect trees from cutting, which particularly men brought up. In these discussions, it was also common to comment on how difficult the protection would be in practice:

*"Only to stop cutting. Guards are needed to protect trees."*
*Man, 30 years old.*

*"... but I am just a guest here, I cannot say: do not cut!"*
*A traditional, frequently migrating Shanable man, 60 years old.*

*"I would like to tell people who cut the trees not to do it. A person can only guard trees or move to a new area."*
*Woman, 40 years old.*

Another measure that was suggested to address the environmental changes was planting trees, which was suggested in one-third of the interviews, including both the *Shanables* who still moved frequently and other less frequently migrating groups. The pastoralists had rarely planted trees themselves (only 3 women and 3 men had planting experience) and, excluding one frequently migrating *Shanable* woman, all of the pastoralists who had planted trees themselves belonged to groups which stayed for months in the study area each year. They were either *Hawazmas,* who had planted fruit trees in the South or *Fellatas* who had participated in the El Ain Natural Forest Management Programme. In addition, there existed a group of ten pastoralists who had not planted trees themselves but had observed tree planting by others such as relatives, community members and farmers. Nonetheless, it was still common to point out that the pastoralists lacked knowledge on how to plant trees. The challenge of protection of trees from cutting and animals was also brought up, particularly by the men:

*"If you want to plant a tree somewhere, somebody will come and cut it at an early age. I have an interest in planting, but since I cannot guard seedlings it is of no use."*
*Man, 42 years old.*

*"People can plant trees, but we do not know how."*
*Woman, 30 years old.*

### 5.4.2. Views on planting trees

Questions concerning environmental rehabilitation activities were normally answered either by emphasising that people cannot affect the precipitation or by briefly describing one activity that was either protecting trees from intensive cutting or planting of trees. A man also emphasised that agricultural activities should be stopped, for he believed that after this the local trees would re-emerge naturally since animals would transfer seeds to the cultivated areas.

After the possible ways to address environmental changes had been discussed, some nomadic pastoralists were also asked separately whether they would be ready to plant trees in order to rehabilitate their environment with support from a project where seedlings would be supplied, training given and the protection of trees organised. This question received rarely a negative answer, but it is necessary to acknowledge here that the pastoralists were commonly extremely polite to the researcher and might have wanted to provide her with answers they thought she would like to hear. There were also differences in the answers and how a particular answer was given. While some pastoralists stressed their eagerness to plant trees and their interest in trees in general, others were less enthusiastic:

*"I am very interested to plant trees. I love trees!"*
*Man, 30 years old.*

*"If you give me a tree, I will plant it."*
*Woman, 50 years old.*

Simultaneously, seven pastoralists (including six women) expressed directly that they were *not* ready to plant trees at any occasion. Two of the women were cattle pastoralists *(Hawazmas*) and four *Shanables.* One of the *Hawazma* pastoralists said directly that she had no interest in planting trees, while the other mentioned her old age as a reason for not having the energy to plant trees anymore. The others unwilling to plant trees were all frequently moving *Shanables*, who could not see themselves planting trees because of their constant migration. A *Shanable* man also emphasised that agricultural cultivation is the main reason behind the reduced tree cover and stressed that stopping the cultivation is the right way to get the trees back. Moreover, an interviewed *Fellata* agreed to planting but emphasised that she would only plant if she would get food supplies in return. This request reflected her previous experiences, for she had previously received food supplies as an incentive for the labour-intensive work of digging holes for water catchments and planting

tree seedlings by the holes in connection with the El Ain Natural Forest Management Programme.

Table 7. Conceptions of environmental rehabilitation by nomadic pastoralists (N = 42; 22 women and 20 men)

| View on rehabilitation | Number of interviews in which the views were expressed | | |
|---|---|---|---|
| | Women | Men | Total |
| Protection of trees from cutting is needed | 4 | 11 | 15 |
| People cannot address environmental changes | 12 | 2 | 14 |
| Planting of trees is needed | 6 | 8 | 14 |
| I am not willing to plant trees | 6 | 1 | 7 |
| I will only plant trees if I get food supplies in return | 1 | | 1 |
| Protection of seedlings from animals is needed | | 1 | 1 |
| Agricultural production should be stopped | | 1 | 1 |

### 5.4.3. Preferred tree species by nomadic pastoralists

One of the important issues to consider in conjunction with forestry-related environmental rehabilitation is the selection of tree species suitable for various areas. Therefore, it was explored which trees species the nomadic pastoralists preferred in the study area. In the individual interviews, the pastoralists were asked to list five tree species they preferred in the area and to describe how these trees could be used. Because of the length of the interviews, this time-consuming question was not presented to all. Altogether, the question was presented in 27 interviews, including 15 women and 12 men. Totally, these pastoralists described 20 locally-found tree species, of which the majority had also multiple non-wood uses. The environmental literacy of the uses of trees varied only a little between different pastoralists, who normally mentioned similar uses – although in a few interviews also new and different uses were described.

In particular, the nomadic pastoralists preferred five tree species, which were described in more than one-third of the interviews. These trees had some characteristics in common: all of them had leaves that camels and goats could browse and fruits that people could consume. Fruits from *higlij* (*Balanites aegyptiaca* L.), *tabaldi (Adansonia digitata* L.) and *sidr* (*Ziziphus spina-christi* (L.) Desf.) were valued particularly as the providers of complementary food and for their ability to

cure stomach ailments. Fruits from *higlij*, *tabaldi* and *gudim* (*Grewia tenax*) were even used as a "small meal" by adding flour to their juice. Moreover, fruits from *andarab* (*Cordia sinensis*) and *gudim* were used specifically to "decrease blood poverty" (to raise haemoglobin). The bark of *andarab* was also used to heal wounds. The leaves of *higlij* also had a purifying function, for they were used as a soap to wash clothes and to wash the dead before burial. Stones of the fruits of *higlij* had also a specific religious use, for they were used for rosaries.

Table 8. Tree species preferred by nomadic pastoralists (N = 27; 15 women and 12 men)

| Trees | | Interviews in which the tree was mentioned | | |
|---|---|---|---|---|
| Local (Arabic) name | Scientific name | Women | Men | Total |
| *Higlij* | *Balanites aegyptiaca* | 13 | 13 | 26 |
| *Gudim* | *Grewia tenax* | 10 | 14 | 24 |
| *Sidr* | *Ziziphus spina-christi* | 9 | 13 | 22 |
| *Andarab* | *Cordia sinensis* | 9 | 9 | 18 |
| *Tabaldi* | *Adansonia digitata* | 7 | 8 | 15 |

As Table 8 shows, women and men often mentioned the same tree species, and they also described similar uses; gender-related differences in environmental literacy could only be identified in the connection with cosmetic uses of trees. The pastoralist men seldom mentioned tree species that were used for cosmetic purposes or, if they mentioned such species, they did not describe cosmetic uses. The women frequently mentioned trees with cosmetic uses amongst the five most preferred species. These uses normally included burning the wood of tree, which released a pleasant scent and induced a certain skin colour on a woman during the “fuming” practice.

The “fuming” was started by placing a pot into a hole that had been dug in the ground. The pot contained wood that was burned, and a woman, covered with a cloth, sat approximately 1-2 hours above the hole to receive the fumes. Burning the wood of certain tree species and sitting close to the fumes was considered acceptable or even recommended for women to become more attractive to their husbands. “Fuming” was practiced by rural and urban women alike and it was common in the study area. Although "fuming" was thus a common practice, it had private meanings for the people, connected to marital life, which might explain why the pastoral men did not describe this use at all. The women described *habil* (*Combretum spp.*) as a particularly suitable “fuming” tree. Other “fuming” trees were *talih* (*Acacia seyal* Del.) and *shuteh* (*Combretum spp.*) (see appendix 4. for a comprehensive list of trees

preferred by the interviewed nomadic pastoralists and the farmers with their uses described).

Altogether, the literacy of the pastoralists of environmental rehabilitation varied slightly more than their literacy of environmental changes. Over half of the pastoralist women expressed the opinion that people cannot address environmental changes in the study area at all commonly emphasising that the precipitation in the area regulates the changes. Simultaneously, it was also common to state that protection of trees from intensive cutting would be needed, which particularly the men highlighted. Moreover, despite the nomadic living patterns of the pastoralists, approximately one-third of them also suggested that tree planting would be needed – although they had rarely planted trees themselves.

The pastoralists needed and used trees in multiple ways including non-wood uses. The described uses for the same tree varied only a little among the different pastoralists, which already suggested that the pastoralists had mainly learned the uses from each other. This was also confirmed in approximately one-third of the individual interviews in which the source of information was also separately asked. In these interviews, women disclosed that they had received their knowledge by observing and listening to their mothers and grandmothers. Men had observed and learned about the uses from their grandfathers and fathers. Some pastoralists simply referred to "old people" as sources of information. Only one pastoralist, a woman, stated to have learned about a particular use of *gudim* (that the juice from its fruits is recommended as a drink to prevent malaria) from an outside source, a doctor in El Obeid. Only one pastoralist in the sample was literate in the sample, reflecting the fact that the pastoralists had seldom received formal education. Hence, their environmental literacy still largely consisted of traditional, cultural knowledge, transferred among the pastoralists themselves.

Although the sample of nomadic pastoralists included in the individual interviews was rather limited (42 persons), it may be nevertheless claimed that there existed some differences between the women's and men's environmental literacy concerning environmental rehabilitation. Although representatives from both groups expressed doubts about the possibilities of people to address environmental changes, it was more common among the women than among the men to express this doubt. Furthermore, although the importance of protection was also raised in both groups, it was more often highlighted by men than by women. It was also more common among women than among men to directly express unwillingness to plant trees. Therefore, it seems that the men believed more widely in the role of people in addressing environmental changes compared to the women. The pastoral women were thus commonly more fatalistic than the men and believed more often that their

own activities to repair the damaged environment in the study area could not really improve the situation.

As a whole, the nomadic way of life had not naturally encouraged the pastoralists to plant trees, although many perceived tree planting as a beneficial activity. Moreover, particularly the pastoralist men also rather commonly brought up the need to protect the trees from intensive cutting. The pastoralists needed the local trees for their livelihood and used them in numerous ways, including many non-wood uses such as the use as complementary food. All in all, the pastoralists interviewed depended heavily on natural resources of the study area for their livelihood, as also did the sedentary farmers discussed in the following.

### 5.5. Background information on the farmers

All the farmers of this study came from the same village, situated approximately 130 kilometres east of El Obeid. According to the head of the village, the *sheikh,* the village included 500 inhabitants living in 102 households. The village was chosen to represent a farmer community that earned its livelihood from the gum arabic trade by practising agroforestry with *Acacia senegal* trees. As described in chapter 4.6, the study area was part of the gum arabic-producing "gum belt" in Sudan and by including the gum producers in the study, it was hoped to receive information on the smallholder producers' views of the area and their living circumstances.

Another reason for choosing the village was that it had been targeted in the programme "Restocking of the Gum Belt for Desertification Control in Northern Kordofan", implemented by UNSO in co-operation with the FNC in 1980–1995 (chapter 4.8.1). After 1995, the FNC had continued the programme independently. From the beginning, the programme had mainly consisted of distribution of *Acacia senegal* seedlings, although the project has included other activities as well such as environmental awareness raising (Fatma Ramli 2002, personal communication; see appendix 3). The study hence provided an opportunity to study the environmental literacy and management practices of gum-producing farmers who had been targeted with forestry-related development activities during a considerable period of time.

Although the village studied was not originally thought to represent economically more "well-off" villages than the "average" villages in the area, this was perhaps the case owing to the favourable location of the village. The village was situated relatively close to the Khartoum – El Obeid road, which enabled the villagers to travel conveniently in both directions. Moreover, the village was located

approximately 30 kilometres west of the rather sizeable town of Umm Ruwaba that included a lively market area and a number of shops as well as a FNC field office with a tree nursery. The location of the village thus enabled rather easy travelling and interaction with people outside the community, such as traders and government officials, which benefited the economic activities of the villagers.

The study covered 40 individually-interviewed farmers (22 women and 18 men) and farmers who participated in group discussions. The individual farmers were chosen randomly, at the same time ensuring that they would represent diverse age groups and education levels. The village was ethnically homogenous: except for a woman who had entered to the community through marriage, all of the interviewed farmers belonged to the *Jawama´a* ethnic group and were born in the village. The youngest of the interviewed farmers was 18 years and the oldest one 80 years of age. Unlike the nomadic pastoralists who were illiterate (with one exception), the farmers represented, in terms of education, a more diverse group (table 9). The literate farmers included mostly people with a few years' primary education, with an exception of two teachers who had also received secondary education.

Table 9. Background information on the individually interviewed farmers
(N = 40; 22 women and 18 men)

| Sex and literacy level | Number of interviewees by age group | | | | |
|---|---|---|---|---|---|
| | 18-30 yrs | 30-50 yrs | 50-70 yrs | Over 70 yrs | Total |
| Literate women | 7 | 6 | | | 13 |
| Illiterate women | 1 | 4 | 3 | 1 | 9 |
| Literate men | 4 | 8 | 1 | | 13 |
| Illiterate men | 2 | 2 | | 1 | 5 |
| Total | 14 | 20 | 4 | 2 | 40 |

## 5.6. Economic, political and cultural factors affecting environmental activities among farmer women

### 5.6.1. Economic resources

The study village included huts, shelters and fences that were built with available local materials such as grass, wooden poles and stalks from agricultural crops. The *neem* tree (*Azadirachta indica A. Juss.* ) grew commonly on the home compounds and was particularly important as a shade tree, although the tree had a number of other uses as well.

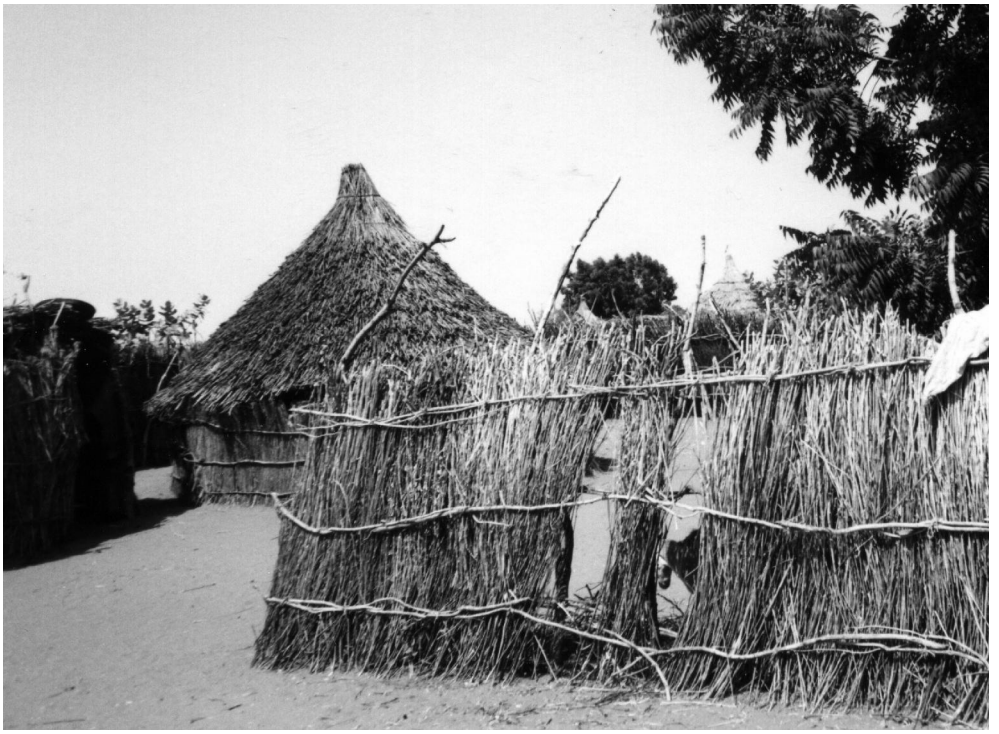

Photo: Anu Eskonheimo
Figure 10. A hut in the farmer village

Precipitation had a major impact on the agricultural production, which provided the main source of livelihood for the villagers. The agricultural fields surrounded the village, on sandy *qoz* soil where most of the villagers cultivated *hashab (Acacia senegal)* trees in traditional farming system. In addition to *hashab* that provided gum arabic for sale, the cultivated agricultural crops included sorghum (*Sorghum bicolor*), pearl millet (*Pennisetum typhoides*), *karkadeh (Hibiscus sabdariffa*), sesame (*Sesamum*

*indicum*) and groundnut (*Arachis hypogaea*). Furthermore, chickpeas (*Cicer arietinum*), okra (*Hibiscus esculentum*), and watermelon (*Citrullus lanatus*) were also cultivated.[6]

In addition to crop cultivation, most farmer households had also other sources of income. These sources of livelihood were discussed in all individual interviews (see appendix 2). The interviews disclosed that it was common that particularly the young men migrated each year to work for months outside the community to earn additional income for their families. In fact, from the majority of the interviewed households (excluding the wealthiest families and female-headed households) a man had migrated during the year 2002, when the fieldwork was conducted. During the time of the research, men migrated mostly to Khartoum. There, the men did whatever work was available such as working in bakeries or on construction sites. Most of the men returned back to help their families during the cultivation season.

Some men had also found work in the towns of the area such as working in the eating places in El Obeid or selling sweets in Umm Ruwaba. Farmer women and men also earned income by assisting other farmers in the area in their farming work, although the villagers also helped each other free of charge during the harvesting. Moreover, a school, village shops and a bakery provided also income for some families. Some women also earned income by selling handicrafts, washing clothes and ironing for others.

Although many households had owned cattle before the great drought in the 1980s, none of the interviewed families owned even a single cow during the time of the research. A few families had, nonetheless, bought 1-2 camels from *Shanables* to transport crops, water and firewood. It was also common to keep a donkey for transportation purposes and rather common to keep some goats. The number of animals was not high; the family with the largest number of animals owned 15 goats and 10 sheep and it was the only family with sheep in the sample.

Compared to crop cultivation, animal husbandry was thus much less important for the farmers' livelihood and due to their limited number, their animals also had relatively limited impact on the environment. Since the cultivation had a particularly important

[6] The researcher learned to recognise the local crops with the help by several people. In the beginning, key informant Samira Abdel Samad (appendix 3) introduced to her various food plants, helping her to connect the local plant names to scientific names. When visiting nomadic pastoralists and farmers, the local people and her research assistants also showed the plants and discussed them.

impact on the environment and was the most important economic asset, the study focused on the size and use of croplands. The land area owned by the 37 households studied (three households were represented by both the husband and the wife in the interviews) varied considerably. The households were divided into the categories of the “poorest households”, “middle income households” and “relatively-wealthy households”. In addition, the “wealthiest household” of all was given its own category, since it was much richer than the others. The group of the “poorest households” included households which had either rented their agricultural land each year from other farmers or owned a cropland plot of 1-5 hectares. The “middle income households” owned 5-20 hectares of arable land and the “the relatively wealthy households” owned 20-60 hectares. The wealthiest family owned 92 hectares of arable land.

However, the categories developed provided only a general idea of the farmers’ economic situation, for the designation was based solely on land and the families had often multiple sources of income. Moreover, the number of household members varied from 3 to 16 people, so that the average number was 8 persons in a household. Thus, the agricultural land had to support a varying number of people in different households. The correlation between the size of the cropland and the number of people in a household was rather unclear. The wealthiest families were normally, but not always, larger than the average of 8 persons.

Furthermore, it is important to recognise several additional points. First, the differences in wealth were very clear. Therefore, even if the wealthiest families were generally larger as compared to the others, they had so much more land than the others that the effect of the number of household members as “consumers” of wealth was not central. Besides, the family members were not only “consumers” of wealth, but also providers of wealth by providing labour in the farms. Secondly, the groups of “poorest households” and “middle income” households included households of all sizes, and the number of household members did not have a clear connection to the cultivated land (larger families did not necessarily have more land than smaller families). Table 10 illustrates the findings concerning the economic status of different families. The wealthier farmers could receive higher income from cash crops such as sesame, because, unlike the poorer families, they were not obliged to sell their crops immediately after harvesting but were able to store crops and could wait until the prices rose.

Table 10. Characterisation of the economic status of farmers' households ( N = 37)

| Characterisation by household category | | | |
|---|---|---|---|
| Poorest households (15) | Middle income households (11) | Relatively wealthy households (10) | Wealthiest households (1) |
| Cultivated 1-5 ha rented or owned cropland | Cultivated 5-20 ha of owned cropland | Cultivated 20-60 ha of owned cropland | Cultivated 92 ha of owned cropland |

An important factor that affected the environmental impact of a household was the size of the cropland that the farmers cultivated, which varied considerably among households. Furthermore, the land-use decisions on what to cultivate and how, affected the environmental impact of a household's cultivation activities. Farmer women had normally less power to decide about cropland use compared to the farmer men. The farmer women's decision-making power over cropland use and other common matters in the households and in the village was affected by gender and by other factors such as the absence of her husband.

### 5.6.2. Culture, politics and the role of farmer women in decision-making

The effect of gender on the decision-making power of the farmer women over household economic resources or assets was studied in all individual interviews. Moreover, participation of the women in the decision-making over family and community matters was also studied in some individual interviews with additional questions and in two group discussions, including a group of women and a group of men. These discussions suggested that gender allowed the farmer women more visibility and more power to influence family and community matters as compared to the women in nomadic pastoralist communities. Women could also travel independently outside their village, although women tended to be less mobile compared to men. For example, if a farmer household had enough agricultural produce to sell it in Umm Ruwaba, the men would normally trade it in the town. If the harvests were smaller, the women (and men) would sell them in the village. This type of task division was not, however, rigid; the interviews revealed that two women had travelled to Umm Ruwaba to sell harvests there. Nevertheless, the men's yearly migration to work in Khartoum and elsewhere outside the community

had exposed them generally to more contacts and influences from outside of the community as compared to the women.

In the village, the farmer women participated in decision-making over community matters. The common matters were discussed in the village meetings that had been organised monthly, except during the five months in the cultivation period starting from May and lasting until October. The village meetings were for all villagers. It was a forum where common issues such as the situation with the school, medical services and the well had been discussed. Moreover, there existed a village committee of seven men and three women. This committee dealt with more practical, everyday issues that were not necessarily discussed in village meetings.

The *sheikh* and his uncle chaired the village meetings. The most respected and influential member of the community was the uncle of the *sheikh*, an older man, who was often referred to as "chief" in the interviews. The *sheikh*, nevertheless, held the official position of the village head and was therefore responsible for many tasks such as land allocation and negotiating with nomadic pastoralists in conflict situations over the use of land. The traditional, powerful position of the *sheikh* was nevertheless sometimes questioned in the village: it was disclosed in an interview that a dispute had emerged between a farmer and the *sheikh* over the use of cropland. The farmer claimed that his family had earlier bought this cropland from the *sheikh*, who was of the opinion that this land had been only rented and insisted on getting a rent for it.

Furthermore, there was another man who appeared as a third particularly powerful member in the community. This man was a teacher and wealthy gum arabic cultivator, who owned small businesses in Khartoum. He had taken the responsibilities to discuss community matters such as teacher salaries and repairing the well with government officials. He had also been active in FNC activities, particularly in developing the gum arabic trade by participating in efforts that had been conducted to increase the co-operation among gum-producing farmers. The important position of these three villagers in their community was also demonstrated in a map that a group of farmer women drew of the study village (appendix 5.). The exercise was a slightly modified version of the PRA exercise "Village Resource Map" (see FAO 2004). At the beginning of the exercise, the researcher asked a group of women to draw a map of the village indicating important places. After the map was drawn, the research assistant wrote the place names in English on the map. Amongst the various places important for the women (such as their own homes and school) the map also included the homes of these three influential community members.

The women of the village did not include people with similar influence on community matters than the most powerful men in the village. The women were not expected to solve difficult common matters such as land conflicts with nomadic pastoralists, either; it was the task of the *sheikh* to get involved if a household's crops had been damaged by nomadic pastoralists' animals and the matter had not been settled by the farmers and pastoralists themselves. The *sheikh* had sometimes appointed a farmers' committee to support this work. The committee that had consisted of 4-5 respected men in the community had estimated the damage inflicted on farms. After, the committee and the *sheikhs* of the farmers and the pastoralists had negotiated the fees pastoralists had been required to pay for the damage in farms. If the settling of the dispute had still failed, the farmers had contacted the local police to pressure the pastoralists – although turning to police was not according to the traditional land tenure system according to which negotiations over land use should now occur between the regional tribal leaders of the farmers and the pastoralists, known as *umdas*.

Nevertheless, although the men held the main power in the community, the women participated in communal decision-making by stating their opinions in the village meetings, and the village committee also included women members. Women-specific work in the village was also appreciated. Women were the organisers of such events in the village as funerals and weddings, which were considered important common ceremonies and also discussed in the village meetings. These events required co-operation, since many individual families lacked the resources to organise such events themselves. There even existed a women's group in the village that had extra cooking utensils such as plates and trays that could be borrowed for such occasions.

At the household level, the women's role in decision-making and in economic decision-making in particular was significant, although the men were still generally the final decision makers in economic matters. The women's role in economic decision-making at the family level was discussed in all individual interviews (see appendix 2), which also revealed differences in household power relations. In two of these interviews, male household heads stated that they alone decided on cropland use (on what to cultivate, how much to sell and when, etc.). In most of the interviews, the decision-making was nonetheless described as a process involving all the adult family members whom the heads of household (normally the oldest men) had consulted before making the final decisions. Moreover, in female-headed households the women were the economic decision-makers and the economic decisions made in the households headed by young men, were under the responsibility of their wives during the months that the men had migrated to work

outside the village. Furthermore, some women had inherited their own, small plots, where they could cultivate whatever they wanted.

Hence, it can be concluded that while some women made economic decisions solely or together with their husbands when they were present in the village, *the majority of the farmer women did not have the final decision power over what was cultivated in most of the croplands or on other economic matters.* Excluding the female-headed households, men were also in the charge of the gum arabic trade in the families. Nonetheless, *most of the women had been consulted about economic matters and had thus participated in family decision-making.*

### 5.6.3. Livelihood activities of women farmers

Women farmers were not the most influential community members and the majority of them also lacked the final decision power over economic matters in households. At the same time, they had visible roles in the households and in the community, participating in economic and other decision-making. Women also conducted most of the agricultural work in practice and had a major effect on croplands. The croplands were discussed in all individual interviews (see appendix 2), which revealed that in most of the households the cultivated land had been acquired through inheritance. Some of this land (or even the whole of the land in some rare cases) had been inherited by the wife, although this was not always the case. Thus, the men had inherited most of the cultivated land.

The interviews disclosed that the majority of the farmer households practiced traditional agroforestry. In their system, the agricultural land was divided into separate blocks that included either agricultural crops or fallow land where *Acacia senegal* grew. Every year, the land for agricultural crops was first prepared by cutting the grass and burning the land. Farmers also rotated different crops inside this area every year in order to increase the production (and simultaneously, to rehabilitate the soil fertility). The farmers cultivated the land as long as the agricultural production did not drop too low, after which they let the land go fallow. A specific characteristic of the fallow land was that it had *hashab* tree (*Acacia senegal*) growing on it. The land that had been previously used for agricultural crops and that was now left fallow, already included stumps of *hashab* trees that had been left there when the trees had been removed at the end of the previous fallow period. *Acacia senegal* has a capacity to coppice, but during agricultural crop cultivation the farmers controlled the coppice shoot re-growth by cutting.

Farmers also used seeds to plant *Acacia senegal* trees. While the lands lay fallow, the *Acacia senegal* trees were left to grow freely and when they were large enough, the gum tapping could be started. The tapping was normally conducted twice a year, mainly in October-November and in January. It was the only agricultural task that predominantly only men would conduct. The men wounded mainly the branches and to some extent, the stem of the tree, after which the gum appeared slowly, forming lumps that normally were collected by the women and children approximately 10 days after the treatment. This gender-based division of tasks was not rigid, for some women also tapped the gum either alone or with their husbands. According to the farmers, the tapping could normally start after the trees had been left to grow freely on the fallow land for 3-4 years. The tapping would continue over a period of 10-15 years. After this tapping period, the farmers removed the old trees, leaving the stumps, and ended the fallow period by resuming the crop cultivation.

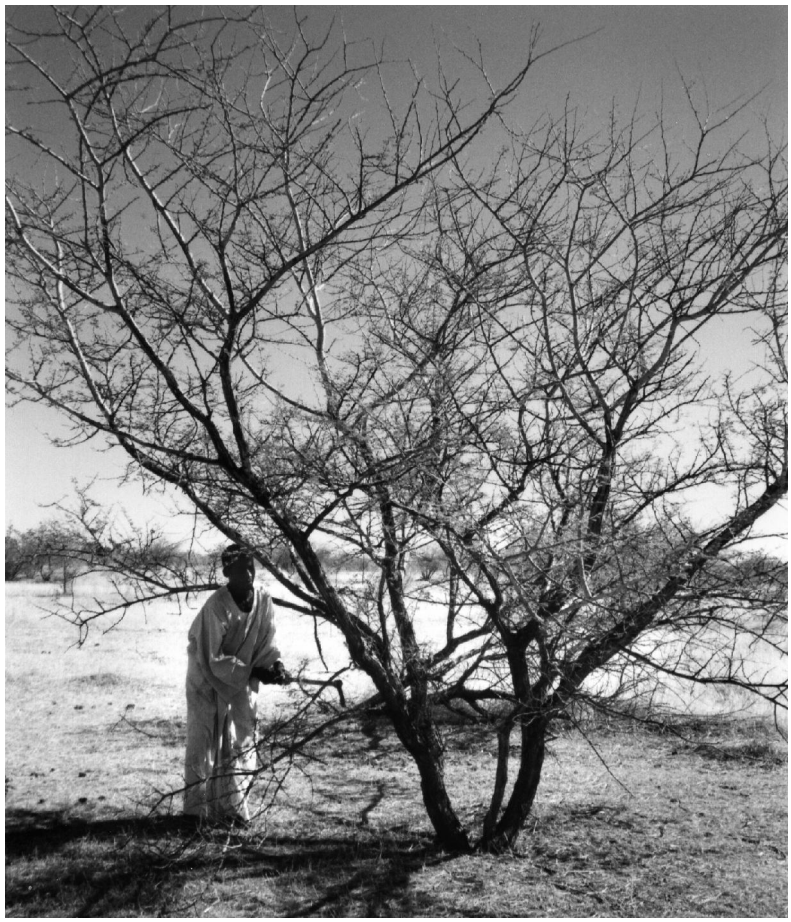

Photo: Anu Eskonheimo

Figure 11. A farmer tapping the *Acacia senegal*

Although the farmers expressed difficulties in presenting estimations of the exact duration of their current fallow periods, the estimations received suggested that the fallow period lasted most often 13-20 years in the farming systems. The fallow period was thus commonly rather long, enabling the soil to fully "recover" after agricultural production. The farmers cultivated agricultural crops during short time periods, which varied between households. The farmers most commonly estimated that the duration of agricultural crop production was approximately 4-5 years, but also other estimates were presented ranging from two to seven years.

However, many farmers expressed difficulties in estimating the number of years during which the land was allowed to remain fallow or during which agricultural crops were cultivated. They stressed that their system of cultivation was not organised according to rigid number of years, but rather, it was affected particularly by the production ability of the land reserved for agricultural crops. Each farmer household decided about their own cropland use and determined the level of production that indicated that the land should go fallow. It is hence challenging to interpret what the farmers' descriptions of differences in the estimated cultivation periods actually disclosed about the state of agricultural lands. Nonetheless, based on descriptions by some farmers of extremely short periods of agricultural production, it seems possible that some croplands that had been allocated for agroforestry had experienced land degradation. At the same time, the farmers still commonly used long fallow periods, which would not suggest a wide spread land degradation in the cropland areas owing to shortened fallow periods.

Some farmer households were not able to follow the traditional agroforestry system. These families had to rent their land each year from different farmers, or they owned very little of agricultural land (they belonged to the category of the "poorest households" in Table 10). Normally, the poor families used practically all the land for producing agricultural crops for their own use and those families that rented the land could not, naturally, even have a long-term system of land use. In this respect, the intensive land use that excluded the traditional long periods of fallow was clearly connected to a low economic status (poverty). Obviously, also the agricultural practices of the women were affected by the economic status of their households, and it may be therefore concluded that poverty intensified the women's farming practices.

Apart from crop cultivation, another women's activity that affected the environment, was fuelwood collection. The issue of fuelwood was discussed in approximately one-third of the individual interviews, by presenting questions additional to the "basic list" of questions. The women needed a steady supply of firewood in order to prepare food on the open three-stone stove that was most

commonly used. The majority of the households also had also a charcoal stove, which most of them used only occasionally (with the charcoal obtained from firewood) to cook tea or coffee.

Although the farmers could obtain some firewood from the trees on their farms, most of the firewood was collected from common property land by women who cut the suitable firewood wherever it was found. Most women collected firewood once a day, after the farm work. If a woman had to transport the firewood by foot, the daily firewood collection took approximately 1-2 hours. Some women (and some young husbands who also collected firewood) could, however, use either donkeys, or in few cases, camels to transport the firewood. These farmers collected a pile of firewood that lasted for several days.

Farmers used axes to cut firewood, but stressed that only “dry wood” was used ("dry wood" referred to either dead trees or dry parts of trees that had no leaves). The dry wood was so much preferred that some farmer women had adopted a practice where they dried parts of the trees on their croplands by making cuts in them with axes that were used to cut fuelwood. Later, they cut the firewood from these dried parts. As a whole, although the wealthiest farmers could afford to buy charcoal on a regular basis, normally the farmers depended on their own fuelwood collection. Some farmers reported that the government had tried to introduce gas to them. They did not, however, feel comfortable using gas, for they were afraid of gas explosions and fires which would rapidly spread in the village with huts made of grass and wood.

Another livelihood activity that affected the environment was construction that was discussed with additional questions in some individual interviews and with a group of farmer women. Unlike all the building tasks which were done by the farmers themselves, only some carpentry was done by the villagers who otherwise bought furniture from Umm Ruwaba town when they could afford it. Farmer men were the main builders in the village and they built the huts. The women assisted in building by bringing building materials such as wooden poles and grasses. The women also built additional shelters in their household compounds, although the men prepared the roofs for them. It was estimated that a shelter normally lasted for 2-4 years depending on which trees were used for construction. A hut normally lasted approximately three years. Hence, building had some impact on the environment, although a constant supply of wood for construction was not needed.

In order to discuss further farmer women’s livelihood activities and their daily environmental interaction, the researcher asked a group of farmer women to prepare a “seasonal calendar”. The "seasonal calendar" is a PRA exercise which includes

identifying women's tasks during the course of the year. The "seasonal calendar" of the women in the farmer village studied is presented in appendix 6 By summarising the various tasks they had to conduct during the year, the women disclosed their annual work burden.

## 5.7. Literacy in environmental changes among farmers

### 5.7.1. Occurrence of the changes according to farmers

The environmental literacy of the farmers was studied in a manner to that in the case of the pastoralists' first by inquiring whether the farmers believed that their environment had changed over the years and if needed, asking more specifically how it had changed. Excluding a young woman who was new in the area due to her marriage, all other farmers described clear environmental changes. *Reduced cropland productivity* was the most commonly mentioned change, stated in 33 (83%) of the individual interviews:

*"This land used to be very fine. We used to have many seeds and nice farms. There was a lot of karkadeh and sesame and we had more money."*
*Woman, 23 years old.*

*"There used to be a lot of crops and green trees that kept the crops inside the ground. People were able to bring many things from Umm Ruwaba such as nice furniture. Now people can only afford to eat."*
*Woman, 75 years old.*

A farmer woman also described that her family used to dig large pits in the ground to store sorghum and other crops, for their land used to produce so much more. Sometimes the family had been able to keep the crops stored for more than two years. Now, they could no longer store crops. Thus, discontinuation of the practice of storing surplus crops, which seemed to have occurred at least since the 1980s in the area (see chapter 4.2), was also brought up in an interview of this study.

In addition to the decreased cropland productivity, another frequently stated environmental change was that the vegetation and particularly, *the trees had decreased* in the study area. In general, most of the farmers mentioned only one change, although approximately one-third of them mentioned two signs: a reduced cropland production and a decrease in number of trees. In addition, some stated that there were fewer "green trees". Thus, these farmers did not actually highlight that the number of trees had been reduced, but that the quality of trees had changed. "Green"

trees had leaves and were in better condition compared to trees without leaves that were either partly or completely dry. Additionally, two men also emphasised that there used to be more animals in the past.

Table 11. Farmers' perceptions of environmental changes (modified version of the table presented in Hares et al. 2006, 136; N=40; 22 women and 18 men)

| Environmental change | Number of interviews in which the change was described | | |
|---|---|---|---|
| | Women | Men | Total |
| The land produces less crops | 18 | 15 | 33 |
| The vegetation cover (particularly trees) has decreased | 9 | 15 | 24 |
| There are fewer green trees | 1 | 2 | 3 |
| There are fewer animals | 0 | 2 | 2 |

### 5.7.2. Conceptions of reasons behind environmental changes among farmers

The reasons explaining the environmental changes in the area were discussed with most of the farmers. Above all, the farmers stressed that reduced precipitation was behind the environmental changes in the area, stating this in all of the interviews where the topic was discussed. Some farmers stressed that particularly the drought in the 1980s had had long-lasting effects:

*"The drought in the 1980s destroyed everything. All these trees have grown after it. Also the animals died, because of the drought. As a result of the drought many people left the village to look for food and water."*
*Man, 30 years old.*

In addition to the reduced precipitation, approximately one-third of the farmers stated that local people had also caused environmental changes. In some of these interviews the cutting of trees was mentioned as a reason for changes in the environment. A few farmers stated briefly that "people cut the trees" without specifying why the trees were cut or by whom. Some others specified, however, that trees were cut to sell firewood or charcoal:

*"...now the people cut most of the trees to get cash, because of the poor harvests."*
*Woman, 55 years old.*

Furthermore, a farmer woman also said straightforwardly that she had to sell firewood and grass to earn extra income, since her husband had taken another wife and lived elsewhere without supporting her financially. Particularly intensive cutting of trees was also practiced among the farmers connected to the fuelwood trade. Farmers who traded wood were the poorest people who had to do it in order to maintain their livelihood. Similarly to the pastoralists, the farmers did not suggest that collection of firewood for their own use had caused environmental changes. When some farmers were asked separately whether they thought that cutting trees for domestic firewood consumption had damaged the trees, most of them agreed. At the same time, a man and two women emphasised that firewood collection had not contributed to the environmental changes, for only such dry parts or dead trees that were not useful anymore were cut. Two men also stated that felling trees in order to clear land for agriculture had affected the environment and emphasized that there are more farmers in the area than before.

Some villagers also suggested that farmers had contributed to the environmental changes by environmentally harmful farming methods. Two farmer men stated that cultivating the land without adequately long fallow periods had affected the environment negatively. Also a few farmers described the uncontrolled use of fire as one factor destroying the environment:

*"Because of fire, some people lose a lot of trees. The trees become very dry and will not grow again. People burn their lands before cultivation. This sometimes spreads and burns grasses and trees."*
*Man, 30 years*

*"It used to be better. Now there is less of everything. The land does not give the same crop. The people usually cultivate the same area for many years and this will reduce its productivity. The rain has also diminished. The rainy season is now short and the crops do not get ready."*
*Man, 39 years old.*

A man also mentioned that animals had affected the environment by eating grass and two women believed that the wind was particularly harmful to the environment. One of them, a teacher in the village school, described that environmental changes had occurred as a result of a process in which human activities, the wind and the spreading sand had interacted:

*"After people cut the trees, the wind destroys the growing trees. Also the farms get destroyed, because the trees stop the sand from entering the farms."*
*Woman (teacher), 32 years old.*

A farmer also mentioned that the low price of gum arabic had affected farmers' decision-making on what to cultivate in their fields. He said that people had cut the *hashab* in their croplands, since they had not been valuable enough and cultivated other cash crops instead. He emphasised, however, that this had been a particularly significant problem in the past when the price of gum arabic had been very low.

Table 12. Farmers' perceptions of the reasons behind environmental changes (modified version of the table presented in Hares et al. 2006, 136; N=40; 22 women, 18 men)

| Reasons behind changes | Number of interviews in which the reason was described | | |
|---|---|---|---|
| | Women | Men | Total |
| Reduced rainfall | 21 | 18 | 39 |
| People cut trees | 1 | 1 | 2 |
| People cut trees to sell as fuelwood (firewood and charcoal) | 3 | | 3 |
| Farmers fell trees in order to clear land for agriculture | | 1 | 1 |
| Farmers have reduced fallow period in the farming system | | 2 | 2 |
| Farmers' mismanagement of fire in the farming system | 1 | 1 | 2 |
| Animals feed on grasses | 1 | 1 | 2 |
| Low price of gum arabic has encouraged felling of *hashab* in croplands | | 1 | 1 |

## 5.8. Conceptions of environmental rehabilitation among farmers

### 5.8.1. Views on the role of people in addressing changes among farmers

Farmers' views on environmental rehabilitation were investigated by inquiring whether they believed there is anything people can do to address the environmental changes in their home area and if so, what could be done (see appendix 2). In general, the farmers were doubtful about the role of people, for the majority of them believed that there is nothing that people can do to address environmental change. Particularly the women were sceptical about the possibility of local people to address environmental changes: the clear majority (73%) of farmer women believed

that people cannot address changes in any way, emphasising that variations in precipitation had caused the changes. In some interviews the farmers emphasised the role of God as a regulator of rain:

*"Only God can help. It just depends on the rain."*
*Man, 80 years old.*

*"Only rain can help."*
*Woman, 38 years old.*

*"The land is good, but we need rain!"*
*Woman, 45 years old.*

Farmers who believed that people could address environmental changes normally described only one method in each interview to address environmental changes. The suggested methods included planting of trees, protecting trees from intensive cutting or from animals, improved farming methods and awareness-raising activities. Planting of trees that were normally specified as *Acacia senegal (hashab*) trees was the most commonly suggested method:

*"People can grow a lot of hashab!"*
*Man, 18 years old.*

Many farmers, including both women and men, had planted particularly *hashab* and *neem (Azadirachta indica)* on their private land; either on their agricultural land or on their homesteads. Most households that practiced the traditional farming system, had also a few scattered *hashab* (and sometimes also other trees) growing among agricultural crops. The farmers stated several reasons why they believed that letting some trees grow inside the land allocated for agricultural crops was beneficial. Some farmers believed that it was useful to have trees in the cropland to provide firewood, building material and fruits. The most commonly-mentioned reason to grow trees among the agricultural crops was, however, that the trees provided shade for the crops. A few farmers also expressed that the trees protected the land from soil erosion caused by the wind:

*"Sometimes I grow hashab with crops. It gives more crops and protects the soil from wind. The wind will not take the soil."*
*Woman, 45 years old.*

Some farmers also suggested protection of trees against intensive cutting to address environmental changes. The farmers presented protection always together with other activities such as awareness raising or planting of trees:

*"Awareness raising for people to protect the vegetation cover is very important... Also, forbidding intensive cutting of trees."*
*Man, 38 years (teacher)*

*"People can grow some trees and stop people from cutting the trees."*
*Woman, 32 years (teacher)*

*"If people would stop cutting the trees and animals would be stopped to eat the forests, this would improve the environment. If a person cuts a dry tree, he should plant another tree!"*
*Man, 29 years*

As described earlier in this chapter, the commonly practiced traditional agroforestry farming system included rehabilitative activities such as a long fallow period with *hashab* and a short period of cultivation of agricultural crops during crops were rotated every year. The land used for agricultural production was also commonly protected from wind and heavy rain by growing some scattered trees with the crops. Moreover, the farmers fertilised their land with available animal manure, although these additions seemed rather modest due to the limited number of domestic animals. The farmers thus managed commonly their croplands in a rehabilitative and protective way. Some farmers nonetheless believed that environmental changes could be partly addressed with improved farming methods. Three farmers emphasised that a fallow period should be long enough, and mentioned that some people had shortened the period.

Furthermore, some farmers acknowledged that the already widely-conducted practices of fertilising the agricultural land by leaving part of the crops residues there and letting the animals enter those lands and burning the land every year were useful activities to enrich the soil. At the same time, a few farmers pointed out that additional effort should be made for preventing fire from spreading in an uncontrolled way. One of these interviewees was a teacher in the village school who also suggested that the spreading of fire could be avoided by cleaning properly the trees and grasses from a field, before burning the ground.

None of the farmers suggested themselves that the cover crop *guar (Cyamopsis tetragonoloba* (L.) Taub.*)* could be used to increase the soil productivity. The researcher asked some farmers separately about this plant (after she had learned about it in one interview) and found that many people knew about this plant. Some

of them had tried the plant and they were satisfied with the result, describing an increased productivity. *Guar* had been brought to the community only once by a private company and was now available only in El Obeid, but none of the farmers had travelled to El Obeid to buy seeds of this plant later on. Chemical fertilisers were rarely used to increase the productivity of the croplands. When tried by a few households, the fertilizers had increased the yield, but farmers emphasised that the prices of chemical fertilisers were too high to allow their use on a regular basis.

### 5.8.2. Planting trees for environmental rehabilitation

Farmers did not believe that tree planting could significantly address the environmental changes, which were believed to be mainly caused by the fluctuating precipitation. Trees were, nevertheless, seen as an important resource that was needed for the livelihood, for they provided gum for sale, firewood, building materials and fruits for complementary food. The function of trees as providers of shade was also important in the hot conditions of the area. A farmer woman also brought up particularly the aesthetic value of trees, stating that the trees "make the environment beautiful". As a whole, the planting of trees was nonetheless a familiar activity for the farmers, who had done it both with seeds and seedlings, many of which had been distributed by the FNC. A few most active tree growers in the community had visited the FNC nursery in El Obeid and collected some seedlings from there.

The planting had been, however, always conducted on land belonging to the farmers and reforestation in common property land seemed to be a foreign idea to the farmers, and only suggested in one interview. Moreover, the issue of limited water resources was commonly raised in connection with tree planting; the farmers emphasised that many planted trees had died because of the lack of water. In addition, some farmers criticised the suggestion for tree planting, maintaining that planting trees would require labour and would not address immediately the villagers' most urgent needs:

*"They (trees) take a long time to grow. People have immediate needs in this village; their stomachs are empty and there are not enough people in the village to water the trees." Woman, 60 years old.*

Table 13. Conceptions of environmental rehabilitation by the farmers
(modified version of the table in Hares et al. 2006, 136; N=40; 22 women and 18 men)

| View on rehabilitation | Number of interviews in which the view was expressed | | |
|---|---|---|---|
| | Women | Men | Total |
| Environmental changes cannot be addressed | 16 | 10 | 26 |
| Planting of trees is needed | 3 | 3 | 6 |
| Protection of trees from cutting is needed | 2 | 2 | 4 |
| Fertilising is useful for agricultural land | 2 | 2 | 4 |
| Fallow period needs to be sufficient | 1 | 2 | 3 |
| Fire control in croplands should be improved | 1 | 1 | 2 |
| Protection of trees from animals is needed | | 1 | 1 |
| Awareness raising about environmental matters is needed | | 1 | 1 |

### 5.8.3. Tree species preferred by the farmers

The time-consuming question on the five most preferred tree species was asked in 27 interviews, including 15 women and 12 men. While a similar number of nomadic pastoralists had mentioned a totally of 20 locally found trees that they particularly liked, the farmers mentioned 12 local tree species. Moreover, while the nomadic pastoralists had had no difficulties in listing various trees, some farmers felt that it was difficult to identify five particularly useful tree species. Furthermore, the farmers listed fewer fruit trees as compared to the pastoralists, although also the farmers preferred trees that had non-wood uses. The literacy of the uses of trees among the farmers did not vary a lot, although there was slightly more individual variation and differences of the knowledge of uses compared to the group of nomadic pastoralists.

The farmers clearly preferred most of all the *hashab (Acacia senegal)* and the *neem* (*Azadirachta indica*) trees. *Hashab* was valued for gum arabic, fodder, building material, protection (for crops), firewood and charcoal. *Neem* was appreciated for shade, building material and medical uses (particularly to cure malaria). Farmers also used *neem* for pesticide against insects that destroyed agricultural crops. Some simply crushed the *neem* leaves and applied them on crops either in the field or in storage. Some others crushed the leaves, boiled them and put the mixture in a spray bottle. The farmers had learned about the suitability of neem as a pesticide from both sources inside their village (family members) and those outside the village (uncle living elsewhere; a person in Khartoum).

In addition to the two most popular trees, *hashab* and *neem*, there were three other tree species which were mentioned in more than one-third of the interviews. Both pastoralists and farmers valued highly *higlij* (*Balanites aegyptiaca*). The farmers used its fruits for complementary food and to cure stomach pains, and preferred it as building material. A farmer also described that its fruits can be used to cure bilharzias, which he had heard from a doctor in Khartoum. Similar to the nomadic pastoralists, the farmers also used the stones from its fruits to prepare rosaries.

The fruits of the fourth preferred tree, *sidr* (*Ziziphus spina-christi*) were used for complementary food and to cure stomach ailments. Moreover, the leaves of *sidr* were used to wash the corpses, before they were buried, and some farmers used its leaves to wash their hair. It was also rather commonly described as a suitable tree for building material and fencing. Furthermore, some farmers described *habil* as a particular suitable tree for firewood owing to its pleasant odour and the women also described *habil* as a suitable tree for the "fuming" practice. *Habil* was the only tree with cosmetic uses that was mentioned by the farmers, and generally, this study could not really identify any clear gender-based differences in the tree preferences and the knowledge of the uses of trees among the farmers.

Table 14. Tree species preferred by farmers (N=27; 15 women and 12 men)

| Trees | | Interviews in which the tree was mentioned | | |
|---|---|---|---|---|
| Local name | Scientific name | Women | Men | Total |
| *Hashab* | *Acacia senegal* | 15 | 11 | 26 |
| *Neem* | *Azadirachta indica* | 15 | 10 | 25 |
| *Higlij* | *Balanites aegyptiaca* | 7 | 7 | 14 |
| *Sidr* | *Ziziphus spina-christi* | 4 | 9 | 13 |
| *Habil* | *Combretum spp.* | 6 | 3 | 9 |

The study did not identify clear gender-based differences in how the farmer women and men perceived environmental changes and environmental rehabilitation. The farmer women were slightly more doubtful than men concerning the possibilities of local people to address environmental changes, but also many farmer men had limited faith in such possibilities.

In some interviews, the farmers were also asked where they had learned about the uses of trees that they had just described. These interviews suggested that the environmental literacy of the farmers was still largely cultural knowledge, learned from other members of the family or from other community members. At the same

time, other sources of information had affected the use of trees and the land by farmers. For instance, the farmers had learned about certain tree uses from people outside the community or from the company that had introduced the soil-improving cover crop *guar*. Thus, the various sources of information, personal interests, experiments and the household wealth (that had affected the use of fertilisers) had caused some individual variation in the environmental literacy of the farmers.

Although the farmers did not generally believe that local people could significantly affect the largely precipitation-related environmental changes in the area, their views on environmental rehabilitation included varying perceptions. Although most farmers (particularly the women) underlined that there was really nothing anybody could do to address environmental changes, some farmers believed that changes could be addressed, to some extent, by improved farming techniques as well as by planting and protecting trees. The variation in perceptions was not determined by education, for various views were expressed both among the literate and the illiterate farmers. Economic status, however, affected how the poorest households perceived environmental rehabilitation. Some farmers expressed frustration over even talking about environmental rehabilitation, since the lack of such necessities as food was seen as a much more urgent issue. These families had to survive and this had required sometimes exploitative use of the environment, for instance, cutting trees intensively for selling fuelwood or cultivation without fallows or using short fallows.

### 5.9. Land degradation and rehabilitation: the impact of women's activities

In sum, the direct environmental impact of pastoral women's livelihood activities in the study area was generally limited. Most commonly, the pastoral women affected the area by collecting firewood for cooking, but the environmental impact of collecting firewood was reduced by the methods of collection: the women collected firewood mostly without tools, breaking with their hands thin branches from trees and using only a part of each tree, preferring such parts of trees that had dried. Furthermore, the particular environmental impact of the firewood collection by the frequently migrating camel pastoralists was even more limited, for they only passed through the area twice a year.

Collection of firewood by pastoral women might have, nevertheless, contributed to land degradation. This could have been the case when the women cut trees in such places that had been already intensively used by people and their animals (the intensively used places close to towns and villages, at *hafirs* etc.).The intensive use of trees in such areas, together with limited precipitation, had perhaps resulted

disappearance of trees. Moreover, *the poorest pastoral women (and men) had been involved in cutting trees for fuelwood trade. This activity had included the most damaging use of trees, also involving the use of an axe and removal of whole trees.*

The pastoral women also used the trees for building material and carpentry. The environmental impact of carpentry was, however, reduced as a result of increased commoditisation. Furthermore, using the building poles as long as possible and buying long-lasting poles in markets had reduced the environmental impact of building of huts. The common activity of "fuming" was a gender-specific activity that affected the trees in the area, and although the amount of wood needed for this practice was much smaller compared to that for firewood, it probably had a small additional role in land degradation, since certain tree species were intensively cut for this purpose.

Mostly, *the pastoralists seem to have affected the environment by maintaining large herds of animals, which consumed grass and leaves and trampled the soil in the area studied*. The impact of animals had increased over the years as a consequence of changes in the pastoralists' migration and livelihood strategies. The men have played roles in these changes by deciding on migration and the livelihood activities in the families, although many women have also participated in these household decisions by stating their views. Various uncontrollable, context-specific factors such as droughts and the availability of markets for animal products had, however, guided the men's decision-making on livelihood strategies.

The nomadic way of life had not encouraged pastoralists to invest efforts in environmental protection and rehabilitation and the possibility of addressing environmental changes by specific means to "repair" the environment was rather foreign idea for many of them. Generally, the pastoralist women were more fatalistic as compared to men, doubting rather commonly the power of humans to mitigate the environmental changes. Simultaneously, some women emphasised that the trees should be protected against intensive cutting and/or suggested the planting of trees. Yet, as previously described: Although the pastoral women did not often express verbally the importance of protecting or rehabilitating their environment, they commonly collected firewood in a manner that minimised its environmental impact.

The activities of the farmer women had affected the environment more compared to the pastoral women's activities. The farmer women (and some men) had affected the environment as fuelwood collectors, cutting the firewood for cooking mainly from common property land and to a more limited extent, from their own croplands. The farmers used axes when cutting firewood for their private use and thus inflicted more damage on the trees by cutting branches compared to the nomadic pastoralist women.

However, the impact of firewood collection on the environment was reduced by the farmers' preference for dry and dead wood. Moreover, similarly to the pastoralist women, also the farmer women collected and burned wood for "fuming". *The poorest women had also cut fuelwood for sale*. Farmer women also affected the trees and the land in the study area by collecting building materials (wood and grasses). Cutting trees for building poles perhaps further contributed to the disappearance of trees and could hence have been a factor contributing to land degradation in some already intensively-used sites, perhaps also affected by the traders of fuelwood.

Furthermore, the farmer women were important crop cultivators who had affected the land by their agricultural practices. The crop cultivation was, however, mostly conducted according to the traditional farming system that included rehabilitative farming techniques. At the same time, the women in poor families had intensified their farming practices by reducing the fallow period, which was likely to decrease the land productivity. Nevertheless, although the farmer women's agricultural practices had a major effect on the croplands, the majority of the women did not possess the final decision power over what was cultivated and how long land was kept fallow.

In addition to their rehabilitative farming techniques, farmer women and men commonly planted trees on their farmland and on their home compounds. Thus, the farmers not only possessed environmental literacy of various tree uses, but they were involved in the management of trees. Planting of trees, nonetheless, only occurred only on private lands and was mostly connected with earning a livelihood by producing gum arabic with *Acacia senegal* trees. Moreover, tree planting was not seen as an activity that could really help the decrease of trees that had occurred on common property land, nor was it perceived as tackling the most urgent problems of the farmers including the scarcity of water and lack of food.

The use of common property land in the study area for any activity that would exclude some of the current land users would pose a challenge, since *scarcity of common property land was a major issue in the area.* From the women's point of view, their use of both the common property land and private land was regulated by men who held the decision-making power over the use of lands in the traditional land tenure regime, which was still largely followed in the area. The regime had determined, for instance, where the women could collect firewood and where they could cultivate land. Moreover, the environmental interaction of the women was also affected by a number of other social factors, such as poverty, or the gender-based division of daily tasks, which will be further elaborated in the following discussion chapter.

# 6. Discussion

## 6.1. Land degradation in the study area from the outsider perspective

The scale and nature of land degradation, its significance to a rural population and the roles that the local people play in degradation, are complicated issues to determine. A previous chapter of this study report presented how the local people themselves described the environmental changes in the study area and their roles of in the changes. In chapter 4 outsiders' views of land degradation in the area, and drylands in general, were presented.

This chapter begins with discussing further these environmental conceptions, with the aim of combining the environmental literacy of various actors in order to strengthen the understanding of the nature of land degradation occurring in the study area and of the roles that local people play in land degradation and environmental rehabilitation. Thereafter, the chapter discusses further the human environment interaction in the area, focusing particularly on the *factors that have affected the local choices of environmental practices* and, in the end, summarising how these factors affected particularly the rural women's choices of environmental activities. Then, based on findings of this study and experiences of local people's participation in development interventions elsewhere, the chapter presents suggestions and perspectives to consider for gender-sensitive environmental intervention in the study area. Lastly, the applicability of the study is discussed.

The manner in which the land degradation of the study area is analysed is based on empirical field work and literal sources. While literal sources provided mainly ecological, natural scientific understanding of the land degradation in the area, the field work focused on local perceptions of environmental changes. Moreover, the researcher observed the environment studied in order to identify the most severely degraded sites, but the field work did not include more thorough, natural scientific studies on the occurrence of land degradation. As a result, previous ecological studies and discussions on the land degradation in the study area, and in other dryland areas, became particularly important for the natural scientific, ecological analysis of this study.

The term land degradation was defined to describe a process leading to *decreased productivity of a land*, *referring to more permanent change of production in drylands than the precipitation-caused decrease* (chapter 1.2). It is therefore recognised that natural scientific studies of land degradation need to distinguish whether identified environmental changes in a study context are precipitation-related and will be most

likely "corrected" later with increased rain, or whether they really are part of more permanent environmental changes caused also by other (human) factors in addition to fluctuating precipitation.

Since precipitation greatly modifies the vegetation cover in drylands, *studying solely the vegetation cover is problematic in order to identify land degradation*. This is why it has been suggested that when the role of grazing in land degradation is studied, the research should not focus on changes in vegetation cover, but on changes in soils (Dougill and Cox 1995, 1). Studying the soils to identify land degradation on tropical farmlands has been previously conducted, including studies on soil erosion (Warren et al. 2001, Warren 2002) and nutrient balance (Dougill et al. 2002, Gray and Morant 2003).

It hence seems that the studies on vegetation cover changes, conducted by the Lund researchers in Sudan (see chapter 4.2.) provided relatively limited information on the land degradation in the study area. In addition, that particular research was conducted two decades ago and some of the methods and technology had also limitations (see chapter 4.2). Based on the studies by the Lund researchers of the study area and the researcher's own observations, it can be therefore concluded only at a general level that precipitation was the main factor regulating the changes in vegetation in the area in question. Moreover, the area was not subjected to large-scale desert encroachment, but rather, land degradation affected various places in the study area to varying degrees.

Since the present researcher assessed the land degradation solely by observation, she could only identify the most degraded places where degradation was visible. These areas included a zone around the El Obeid town, surroundings of Umm Ruwaba town, the sites around commonly used excavated water points (*hafirs*), a site that had been temporarily used for mechanised agriculture, and finally the common property land around the farmer village studied (chapter 4.2). At these sites, the vegetation cover was extremely scarce and it is therefore assumed, based on natural scientific knowledge, that the decrease of vegetation cover had in turn affected the soils at these sites by reducing the organic matter and nutrients in the soil and by exposing soils to erosion (see e.g. Ffoliott et al. 1994, 328-348; UNEP 1997, 26 ).

In addition, sites trampled intensively by large herds of animals such as the surroundings of the *hafirs*, were observed to have become subjected to soil compaction. Soil compaction describes a situation where soil particles are pressed together, resulting in fewer pores in soils. After compaction occurs, it becomes more difficult for plants to emerge and become established, as their root growth become slower. Because of the reduced soil porosity, plants are also affected by reduced rate

of water infiltration and poor drainage from the compacted layer. Furthermore, the decrease of porosity slows the exchange of gases in soils (see Mulholland and Fullen 1991, 189; Siegel-Issem et al. 2005, 215; Jones et al. 2005).

UNEP has presented overgrazing as the most widespread cause of soil degradation in Africa (UNEP 1997, 68). The environmental impact of grazing is, nonetheless, complicated to assess, since the impact of grazing depends on what is in the pasture and which animals are grazing for each animal selects its own plants (Mainguet 1994, 210). Hence, although overgrazing and trampling had visibly affected the environment at some sites in the area under study, the exact environmental impact of overgrazing on the area as a whole is not known and would have been difficult to assess accurately. However, based on observation of a large number of domestic animals grazing in the area, as well as on their clear environmental impact at some sites as indicated by a largely destroyed vegetation cover, it is assumed here that the *impact of livestock* was the most significant single factor that had degraded the land in the study area – interacting in the degradation processes with other factors such as felling of trees and fluctuating precipitation.

UNEP has also presented erosion as a particularly important process that commonly degrades soils in drylands (e.g. UNEP 1997, 26). In this study, erosion is perceived as one of the many factors that affected the environment in the study area. It is acknowledged that although the scarcity of soil-protecting vegetation makes drylands generally vulnerable to wind and water erosion, this might not always affect these areas as dramatically as it first seems. This is because even if a landscape might look desert-like during the dry season, if there exist crowns of trees and roots in the soil, the land is likely to recover in the wet season (see Mainguet 1994, 36).

Soil erosion occurs naturally (UNEP 1997, 26), but human activities may intensify and trigger the soil erosion by destroying vegetative cover (Mainguet 1994, 36; Dregne 2002, 110). In addition to human and animal impacts, the intensity of erosion is affected by natural factors such as the characteristics of wind such as frequency, velocity and turbulence of winds, The characteristics of precipitation such as the frequency of rainfall events, storm duration and raindrop size affect also the intensity of erosion (UNEP 1997, 26).

In the study area, the strong water-induced soil erosion typical for steep slopes is not an issue, as it is characterised by undulating topography. However, since the rainfall is often received in heavy storms, the precipitation is likely to have caused some erosion. The impact of wind is more clearly observable; the area is tormented by sand storms during the dry season. Soil properties affect also the vulnerability of soils to erosion. Soils with high sand content have a poor water holding capacity and

tend to dry quickly due to their large particle size (see Bridges 1995, 17), this makes the soil easily movable by wind. A sandy *qoz* soil known as *Albic Arenosol* according to international soil classification (FAO/UNESCO1977, FAO/UNESCO 1990) dominated the study area (FAO/UNESCO 1977, Olsson, L. 1985, 13) and was cultivated by the sedentary farmers studied.

In addition, outsiders have pointed out that cultivation with unsustainable methods cause degradation of drylands (Graigner 1990, 65-68; Thomas and Middleton 1997, 74-77). However, detailed and long-term soil analyses are needed for scientific verifying of actual land degradation on croplands and clarifying how the changes in production have fluctuated according to the precipitation. But whether the decrease of cropland productivity is caused by precipitation or also other factors degrading the land, the issue of cropland productivity, its maintenance and increase with farming techniques, is naturally crucial for farmers' livelihoods.

Since the 1970s, many researchers have recommended the old, traditional agroforestry systems as a generally beneficial system for agricultural soils (Nair 1989, 610). The specific traditional agroforestry system with *Acacia senegal* that most of the farmers under study practiced, has also been acknowledged as a sustainable farming system with rehabilitative farming techniques (Ballal 2002, 16; Gaafar Mohamed 2005, 11).

Lastly, outsiders have presented intensive cutting of trees as a potential factor causing land degradation in dry regions (e.g. Thomas and Middleton 1997, 78-82). Nonetheless, if land degradation results long-term changes in soils, it is not easy to determine how fuelwood collection has affects the soils in different areas. Vegetation as one of the main factors that affects soils (Bridges 1995, 1), but whether cutting of trees on dryland actually causes long-term degradation in soils may be a complicated matter to verify. Particularly, if only a small and perhaps dead part of a tree is used without harming trunks, the connection between firewood collection and land degradation might be difficult to establish. Complete felling and harvesting of trees affect dryland ecosystem more significantly by reducing the organic material and nutrient flow into soil and making the land vulnerable to erosion and animal trampling (Mainguet 1994, 68).

Therefore, it is unclear whether, for instance, the collection of firewood by the pastoralist women for their own use by breaking thin (and often dry) branches had actually contributed significantly to land degradation in most of the places in the study area. At the same time, it can be suspected that on the sites where the land degradation was observable and where trees were extremely scarce, even this collection of firewood for domestic consumption can be a factor, together with

domestic animals and precipitation, which had caused disappearance of trees. The cutting of trees for building poles had also led to intensive cutting of some trees, but the overall significance of this activity in land degradation seemed limited and was also decreased by the practice of buying some of the durable poles (chapter 5.3.2.).

In fact, the most harmful cutting of trees was connected to poverty, since the poorest people among the pastoralists and the farmers had been obliged to cut trees intensively for selling firewood in order to maintain their livelihood (chapter 5.3.2.). When the collection of firewood for household use is considered, it is obvious that the collection of firewood by the farmers for their own use had affected the environment more than that done by the pastoralists. Unlike the pastoralists, the farmers lived sedentary lives and used axes to cut the firewood. This wood was normally cut from the trees on common property land, although, to a limited extent also trees growing in their homesteads and croplands, mainly *Acacia senegal* growing in their farms, were also cut for firewood.

The firewood collection by the farmers had already created in the 1980s "pockets of firewood deficits" (Olsson, K. 1985, 8) around the farmer villages in the study area. Also in conjunction with this study, an extreme scarcity of trees in common property land was observed around the farmer village studied. The farmers also needed to cut trees for building poles which included cutting trunks. The impact of building on trees was nevertheless less significant as compared to the firewood collection which occurred more regularly (see chapter 5.6.3.).

Thus, from an outsider perspective, some places in the study area appeared to be subjected to land degradation. This degradation had occurred as a result of complex processes where the environment has been affected by climate, people and animals, interacting together. Domestic animals seemed to have caused the most significant degradation in the area and it also seems that the cutting of fuelwood for sale had also contributed to land degradation, because of the resulting felling and removal of trees.

## 6.2. Environmental changes and land rehabilitation from the nomadic pastoralist viewpoint

From the local people's perspectives, the study area had experienced environmental changes that had made it more difficult to earn a livelihood there, and they expressed great concerns about such changes as decrease of trees, grasses and production in farmers' croplands. The main cause of these changes was emphasised to be precipitation, which the local people described to have clearly decreased over

the last decades. Simultaneously, many people suggested that the land users of the study area had also contributed to the environmental changes mainly by excessive cutting of trees or cultivating agricultural lands with unsustainable methods.

The nomadic pastoralists were mostly concerned about the *reduced vegetation cover in the study area including particularly a drastic decrease of tree cover.* They believed these changes had been predominantly caused by decrease in precipitation, although intensive cutting of trees to clear land for agriculture and to obtain fuelwood for sale, were also commonly described as causes of environmental changes (chapters 5.3.1. and 5.3.2.).

The environmental literacy of the pastoralists of the reasons behind environmental changes had some similarities and differences with the results of a study of nomadic pastoralists conducted elsewhere by Michael Bollig and Anette Schulte (Bollig and Schulte 1999). They studied the perceptions of vegetation changes among nomadic pastoralists in north-western Namibia and northern Kenya. The study area in Kenya had a variable topography and precipitation, while the study area in Namibia was a dry region with an environment that had similarities with the one now studied in Sudan.

In these studies, both the Himba nomadic pastoralists in Namibia and the Pokots in Kenya rarely suggested that their livelihood activity of animal grazing had affected the vegetation. Pokots of Kenya explained the reasons for environmental degradation in narratives, told by the elders. In these stories, the youngsters' bad behaviour had angered the ancestors who had then caused environmental changes. The Himbas tended to associate the decrease of grasses to prolonged drought in the area studied, and their literacy of the main causes for environmental changes had hence similarities with the present case of pastoralists, reflecting similarly the biophysical context of the study area. The Pokot perceptions seemed to have been affected most of all by the social context, disclosing information about the social dynamics between the older and younger generation (Bollig and Schulte 1999, 506).

Although the Sudanese pastoralists participating in this study emphasised that precipitation was the cause of environmental changes in the study area, they also commonly stated that local people had caused a decrease of trees by cutting them too intensively. The pastoralists described that this destructive cutting of trees was conducted by farmers and poor people in general, who cut the trees in order to sell fuelwood. Rarely, did a pastoralist suggest that their own livelihood activities of animal herding and fuelwood collection had contributed to environmental degradation in the study area.

The pastoralists had nonetheless for generations moved in the study area and possessed a detailed literacy of its environment, including a rich knowledge of local trees (see appendix 4). Since the pastoralists were knowledgeable of their environment, they had to be more aware of the environmental impacts of their livelihood activities than what the interviews suggested. The unwillingness of rural people to take eagerly responsibility for environmental changes in an area they need for their livelihood is understandable and has in fact also been documented elsewhere (Gray and Kevane 2001, 577; Glover 2005, 65-66, 80). As a whole, the nomadic pastoralists did not present themselves as actors who significantly affected the study area, for they also expressed limited belief concerning their ability to affect the environment positively by "repairing" and mitigating the environmental changes such as the decrease in vegetation cover. They stressed the role of precipitation as the regulator of environmental changes, and particularly the women were sceptical concerning their abilities to address the environmental changes, commonly stating that local people cannot do anything to improve the state of the environment (chapter 5.4.1.).

This "fatalism" was interpreted in this study to result from the limited and erratic precipitation and from the social context that will be discussed more in detail later on in this chapter. Moreover, the nomadic way of life does not obviously encourage the allocation of considerable efforts for environmental rehabilitation such as tree planting, although some pastoral women and men did acknowledge that planting of trees could be beneficial – even when they had rarely planted trees themselves. The community of *Fellata* pastoralists represented an exception, for some *Fellatas* had planted trees owing to their participation in the El Ain Natural Forest Management Programme (see chapter 4.8.2.).

The pastoralist men also commonly highlighted the need to protect trees from too intensive cutting, often also noting the difficulty of such protection on common property land where people jointly used the natural resources (chapter 5.4.2). Their views echo to the concerns that have been raised over the difficulty to control the individual use of common property resources in pastures that may lead to overexploitation of such resources (Hardin 1968, 1244).

However, to perceive the pastoral land use system as inherently exploitative of natural resources owing to its use of common property land seems highly problematic. The perception of pastoralists as overgrazers has been maintained for decades among researchers and development professionals (Fratkin 1997, 240; Bollig and Schulte 1999, 494), but this idea has also been fiercely criticised. It was earlier pointed out that for instance findings in an ecological study in Namibia did not support the idea of generalising communal pastoral management as the universal

reason behind environmental degradation (chapter 2.2.4). Moreover, numerous studies on nomadic pastoralists have also identified their protective use of grazing lands and the effective techniques they have utilised in order to adapt to the fluctuating precipitation in drylands such as changing their migration routes, breeding selectively, modifying the diets and splitting up family entities into smaller units to spread the family herds (Bovin and Manger 1990, 24; Manger 1996, 176; Niamir-Fueller 2000, 250; Casciarri 2002, 33).

The traditional adaptation mechanisms by the pastoralists have, however, become difficult during recent decades because of changes in societies such as the increased privatisation of lands and the generally reduced pastoralist rights to use common property resources (Fratkin 1997, 236; Niamir-Fueller 2000, 250). The weakening of user rights had also affected the nomadic pastoralists in the study area, for their traditional property rights to use land in many places of the study area had been taken away from them when these areas had been allocated for private cultivation.

The interviews of this study suggested that the increased difficulties in maintaining their livelihood in the study area did not attract much attention and understanding among the farmers, who also needed the scarce land for their livelihood. In fact, the farmers believed that they had full rights to cultivate their lands, which they perceived as belonging to them according to the traditional land tenure system. This situation had created conflicts, when pastoralists' animals had entered the farms to and foraged on agricultural crops or the leaves and twigs of *Acacia senegal* trees *growing* on agricultural lands. However, as mentioned earlier, these disputes were now commonly settled peacefully; if a dispute could not be settled between the farmer and the nomadic pastoralist concerned, such a conflict was addressed within the traditional land tenure regime still in use in the area, involving the *sheiks* (see chapters 5.1.1, 5.1.2 and 5.6.2 ).

Hence, from the nomadic pastoralist perspectives, maintaining of the livelihood has become more troublesome due to the decreased availability of land for animals and the reduced vegetation cover on common property land. According to them, the decrease in vegetation cover was caused by factors beyond their control, such as decreased precipitation, poverty-induced cutting of fuelwood for sale and felling trees by farmers in order for clearing land for agriculture. Later, this chapter will discuss how *government policies and economic circumstances* had also affected pastoralists' land use decisions and contributed to an increased concentration of the nomadic pastoralist population in the study area.

## 6.3. Views of farmers on environmental changes and rehabilitation

Similarly to the nomadic pastoralists, the farmers were also concerned about the environmental changes in their home area, particularly stressing the problem of *decreased cropland productivity* and also rather commonly, the *decrease in the number of trees.* The farmers also emphasised that the environmental changes were predominantly caused by the reduced precipitation, although a few also described that local farmers themselves had caused environmental changes by shortening the fallow period and mismanaging the fire in their farms (chapter 5.7.1.). There exist no modern database on wildfires in Sudan, but it is known that they are a significant problem there. In northern Sudan, annual wildfires are common during the dry season when the grass is dry and inflammable. They may also spread rapidly owing to winds and the flat terrain (Bayoumi 2001, 112).

Both the nomadic pastoralists and the farmers nonetheless stressed that the limited and generally low precipitation had been most harmful to the environment in the study area. But although they stressed that the precipitation had decreased in the area, based solely on this information it cannot be concluded that the overall precipitation actually had decreased in the study area during the recent decades. Furthermore, farmers' descriptions of the decrease of in production in their croplands do not necessary verify that a large-scale and drastic decrease of agricultural production had in fact occurred. This is, because combining local environmental literacy to the natural scientific environmental literacy (and western thinking in general), is a complicated matter and several issues need to be considered before conclusions about the studied context can be made.

Previously, some other studies that have the views of farmers on cropland degradation elsewhere have in fact identified local views that first appeared to have disagreed with the natural scientific data and the views of developers. In their study in Kenya, Romano Kiome and Michael Stocking found that the farmers under study did not view erosion as a threat to their croplands in the ways that the researchers and developers did (Kiome and Stocking 1995, 292-295). Warren and others (Warren et al. 2001, 439-440) have identified lack of concern over soil erosion among the farmers in a dry area in south-western Niger.

Furthermore, Leslie Gray and Philippe Morant conducted an extensive study in Burkina Faso, studying croplands in a village. Although the soil analysis that was conducted over a period of eight years suggested very little change in productivity, farmers kept insisting that their agricultural lands had degraded and produced much less than before. The farmers also claimed that this decrease was due to a

decrease in precipitation, although the long-term climatic data for that area disclosed that the 1900s had not been characterised by any substantial decline in the annual average precipitation (Gray and Morant 2003, 434).

These findings made Gray and Morant ponder the reasons explaining the differing views between themselves and local people. They first considered the challenges they had encountered in the interviews in which the farmers had difficulties in connecting changes in soil conditions to the exact time period of eight years that the questions on soil changes were intended to cover. Despite the attempts by the researchers to clarify the questions, it remained unclear whether the reported soil changes actually had occurred in the studied time period of eight years, or whether the changes had occurred in the fields earlier, when the agricultural fields were cleared for the first time.

Gray and Morant reasoned that the tendency to explain the changes in soils since the beginning of their cultivation could perhaps be explained by the soil properties. Studies of soil fertility changes in similar soils in other areas namely suggested that the fertility of such soils tended to decrease fairly quickly during the first years of cultivation. Another issue they raised was that the soil analysis that focused on changes of soil fertility did not study some of the environmental changes that the farmers themselves emphasised. One such change was the increase of weeds that had made many farmers to abandon their fields. Gray and Morant also suggested that the farmers may have brought up reduced the soil fertility, since this would serve as a rationale for some of their agricultural practices such as building stone lines that alleviated erosion (Gray and Morant 2003, 434-435).

Moreover, Gray and Morant thought that the farmers' perceptions could perhaps be explained by population growth and changing farming practices. Population growth had affected the traditional shifting cultivation system so that it had become difficult to find recently fallowed productive land. When assessing whether their cropland productivity had decreased, the farmers might have thought about a situation a long time ago, when there was more of recently fallowed land available. Hence, perceptions of the soil productivity decline might have actually reflected the reduced access to recently fallowed lands. Nevertheless, according to the researchers, the final "perhaps cynical, but nonetheless real effect on farmers' perceptions", was that the soil fertility issue had been the reason for establishment of environmental projects in Burkina Faso. In other words, declarations of soil fertility decline had previously been followed by concrete and material benefits, which might have encouraged the farmers to stress the severity of the problem (Gray and Morant 2003, 435).

Particularly, the investigations by Gray and Morant provided perspectives for the present study on how the environmental literacy of farmers in land degradation can be also interpreted – although simultaneously recognising the context specific nature of environmental literacy and environmental interaction in various areas. Although the absence of long-term scientific soil analysis made it impossible to judge whether the farmers' claims of reduced productivity in their croplands agreed with natural scientific data in this study, Gray and Morant's study suggest that views of farmers on their cropland degradation may provide alternative perspectives to natural scientific knowledge. It was therefore assumed that although the farmers commonly stressed that the reduced cropland productivity was a major problem for them it was also possible that cropland degradation had not actually occurred in such a scale.

The present interviews disclosed that most farmers in the study village still practiced agroforestry. The periods for fallow and for agricultural crops varied among farmer households, which did not have a rigid system of allocating certain years for these two land uses. At the same time, the farmers could provide some estimations of the years a particular land was used for agricultural crops and fallow with *Acacia segenal*; these estimations suggested that commonly no drastic shortening of the fallow period had occurred. Some farmers practising agroforestry described, however, that their households could only allocate short cultivation periods for agricultural crops due to decrease in land productivity. Nonetheless, most clearly, the poorest farmers have reduced cropland productivity, since they were not able to practise the traditional agroforestry due to the small size of their own croplands or because they had to rent their croplands each year (see chapter 5.6.3.).

These findings differ slightly from Mustafa Khogali's conclusions (Khogali 1991, 206) and also from the conclusions of Seif El Din (1984, cited in Ballal 2002, 28) which stated that in the local agroforestry system in the area studied the fallow period had been drastically reduced. The reasons explaining these differences in findings can only be speculated. Perhaps the differences in study methods or the rather favourable economic position of the study village as compared to many other villages in the area accounts for the differences. The precipitation might have played a significant role as well. The cited studies were conducted approximately two decades earlier, during the long dry period that affected the area from the latter part of the 1960s until the beginning of the 1990s. Hence, it is possible that during the previous studies, reduced precipitation made it particularly difficult to achieve sufficient crop yields and consequently, a large number of people was obliged to allocate fallow land for crop cultivation before it had been fallow for the usual, necessary length of time.

Nonetheless, if reduced fallow periods did not explain the widely-emphasised loss of cropland productivity, one may question whether there existed another factor or factors that had caused the alleged large-scale decline in productivity. One factor might be after all climatic, although the precipitation records of the area suggested that the annual average precipitation had not really decreased in the 1900s, which first seemed to contradict farmers' claims of reduced precipitation. However, an analysis of the impact of rain on the soil and the vegetation is complicated by the fact that the statistics on the average annual precipitation do not reveal *how* the rain had fallen in different years. If the rain falls relatively evenly during the growing season it is much more useful for the crops and the natural vegetation compared to a few heavy rain storms during which much water leaches right through the sandy *qoz* soil or is lost by run-off (see chapter 4.4.1.).

Using the mean annual precipitation as a measure of a change in rainfall circumstances is therefore problematic and it is hence even possible that the cropland soils had in fact dried due to the *manner* in which the rain had fallen. An issue to consider in this connection is the possible effect of the global climate change on precipitation. This complicates the matter even more. Climate researchers commonly assume that climate change is likely to add extremity to the climatic events, causing more variability in precipitation. At the same time, scientific studies of climate have not been able to verify that the climatic developments in Africa in the 1900s have been connected to climate change (Hulme et al. 2001, 165). Nevertheless, if climate change had caused more extreme and variable precipitation in the study area, this would have increased the loss of water in soils as a result of increased leaching and run-off. Increased loss of water would have then affected the croplands, increasing their aridity and thus decreasing their ability to produce crops. It is also possible that an increase of temperatures has occurred in the area particularly in the recent decades (see Hulme et al. 2001, 165), which may have caused increased evaporation and consequently, increased aridity in croplands.

These are naturally theoretical speculations which currently would be extremely difficult to verify with climate studies. In this study, the farmers' conceptions of rainfall variability were studied briefly by asking some local farmers an additional question of whether they could explain how the rainfall had diminished over recent decades. Since the farmers found it hard to understand this question, the researcher further clarified it by asking whether the decrease was gradual over the years or whether the decrease perhaps was sudden and dramatic. Answers from farmers were normally short, suggesting one of the two given options, although some of them had described earlier in the interviews the long-term livelihood consequences of the severe drought in the 1980s. In conjunction with these questions, some farmers also started to explain in detail how the rain had come down during the

growing season in the year they were interviewed (in 2002). Hence, the farmers' descriptions of the past were not only affected by memory which vary between people, but also by their *cyclical relationship with time* became also apparent. The farmers assessed carefully the rain during the current growing season and its effect on various crops, but describing even roughly the developments of precipitation over a long period of time was difficult for them.

Cyclical relationship with ecological time among the pastoral Nuer in Sudan has been previously studied by the famous anthropologist Edward Evans-Pritchard. He concluded that Nuer ecological time consisted of one year during which they carefully monitored their biophysical environment and moved with animals based on their observations of climate and vegetation (Evans-Pritchard 1969, 94-104). A similar cyclical relation with ecological time was also found among the nomadic pastoralists studied in the present study when their migration with animals was discussed in the interviews. At the same time, as presented before, many pastoralists had also made changes in their migration routes and livelihood strategies. In this process, their environmental literacy and traditional relationship with environment had become modified.

If descriptions of croplands by cultivating pastoralists are compared with the descriptions by farmers, one notes that the cultivating nomadic pastoralists (even those who have cultivated the same sites for years) did *not* describe that a decrease of production had taken place in their croplands. At least partly, this could perhaps be explained by the soil type that the pastoralists mostly cultivated, since the *gardud* soil, or Chromic Vertosol according to international classification (FAO/UNESCO 1977, see also FAO/UNESCO 1990) had a higher clay content and hence smaller soil particle size as compared to the *qoz* soil that the farmers cultivated. Consequently, *gardud* had a higher nutrient content and water-holding capacity than the *qoz* soil (El-Dukheri 1997, 12) and the *gardud* soil had thus been less vulnerable to the above-described possible precipitation-caused desiccation as compared to the *qoz* soils. Nonetheless, the *gardud* soil also benefited less from precipitation received during heavy storms, since due to the hard surface of this soil, large amounts of water are lost as surface run-off (El-Dukheri 1997, 12). Furthermore, since the nomadic pastoralists normally rented their lands, they did not have a similar long-term interaction with their croplands that the farmers had, which perhaps also explained why decreased cropland productivity was not brought up by the cultivating nomadic pastoralists.

In particular, the farmers often emphasised how beautiful and productive their environment had been before, stressing that negatives changes had occurred during the course of time. It is likely, however, that the change had not been so clear

initially. Since farmers had a predominantly cyclical relationship with time, their thinking focused on the current growing season rather than constructing a linear timeline, where their life experiences and environmental developments would had been placed in exact years – as would be typical in western scientific research. Therefore, when they described the green environment of the past, they perhaps remembered some particular years with a relatively dense vegetation cover and many green trees that could have had occurred at any time before the interviews. The central issue for them was that these years had occurred before the ongoing growing season, which suffered from limited precipitation.

In the study area, the population growth seemed to have not affected the availability of fallow land on a similar scale as in Gray and Morant's study context. However, also in the study area, population growth had effects on local land use and cropland degradation, since many farmers' croplands had become increasingly smaller owing to population growth that had fragmented the inherited land. The poorest families with the smallest croplands (or rented croplands) had been then obliged to reduce or even abolish their fallow periods in order to survive in short-term, which had probably decreased the productivity of such lands. An issue that perhaps affected even more the farmers' emphasis on reduced cropland productivity was the researcher herself who as a westerner perhaps represented potential material support later on for improvement of cropland productivity. It is clear that the farmers generally suffered from low soil productivity in their croplands because of the soil type and general aridity of the area; many struggled to earn their livelihood. There was thus a need to increase their cropland production, and perhaps this need also affected the farmers' answers, making them emphasise the seriousness of the problem of low soil productivity.

The presented local environmental literacy in reduced cropland degradation also demonstrates the kind of challenges that may be embedded in studying environmental conceptions by interviewing local people; since farmers needed to raise their cropland productivity this might have caused them to emphasise that the productivity had decreased. Previously in this chapter it was also claimed that the nomadic pastoralists were likely to perceive themselves as having produced more significant environmental impact on the study area than what they expressed in the interviews.

Moreover, complications in interviewing a young pastoral woman were described in chapter 5.3.1., so as to present an example of the limits of the interviewing method, particularly when the interviewer was not well known in the community. It was noted that locals and specifically those with limited interaction with people from outside their communities, could sometimes experience difficulties in formulating in

interviews what they know about the environment even though they in fact could possess a vast and detailed knowledge of it. It was also noted that the women's workload could sometimes complicate the collection of information using interviews and therefore, complementing the interviews with other methods such as observing and participating in women's daily activities could be perhaps often worthwhile (chapter 5.3.1.).

As a whole, based on farmers' descriptions, it is hence not possible to present accurate conclusions on the occurrence and severity of the land degradation in their croplands. It can be solely concluded that cropland degradation was likely to occur in the plots of the poorest farmers, who did not use the rehabilitative long fallow period and perhaps also, to some extent, in some agricultural land where agroforestry was still conducted. Furthermore, there also existed the possibility of a more wide-spread land degradation problem in croplands, occurring perhaps due to climate change. This would be, however, extremely difficult to verify with natural scientific studies.

Similar to the pastoralists, also the farmers did not eagerly take responsibility for environmental changes. When some women were asked directly in individual interviews whether domestic firewood collection had affected the trees, they mostly agreed. Similarly to the pastoralist women, the farmer women also preferred deadwood for firewood, a protective activity that resulted in less pressure to the living parts of trees. Like the nomadic pastoralists, also the farmers were commonly sceptical about the power of local people to address environmental changes in the area; both women and men expressed doubts about local power to address environmental changes, but particularly the women farmers were sceptical of the ability of local people to address environmental changes (chapter 5.8.1.).

Despite these views, some environmental changes were already mitigated by farmers who cultivated their croplands with the traditional agroforestry system that included protective and rehabilitative practices. In this system, the *Acacia senega* tree*l* increases the fertility of the cropland by increasing its organic-matter content through addition of leaf litter. The roots of *A. senegal* bind the cropland soil and hence alleviate erosion (see Mainguet 1994, 36). *A. senegal* also has the ability to fix important plant nutrient nitrogen from athmosphere (Ballal 2002, 14 -15). Farmers also rotated the agricultural crops every year on land allocated to agricultural production in the farming system, which benefited the soil and increased its productivity. The farmers had also protected and rehabilitated land by planting trees in their homesteads.

Hence, the farmers not only had knowledge of the uses of trees (see appendix 4), but they also had practical experience of planting trees. Nonetheless, excluding the farmers' preference for dry wood, no other protective or rehabilitative measures on *common property land* were identified. Even the idea of rehabilitation of common property land by planting trees was only suggested once, while farmers more often brought up that planting of trees in private lands could be useful. As a whole, planting of trees to rehabilitate the environment was rather rarely suggested by the farmers and it was in fact mentioned in several interviews that the limited precipitation had discouraged tree planting (chapter 5.8.2.).

All in all, the low precipitation had thus greatly affected how the local people perceived environmental changes; it was the rain that was seen as the main regulator of changes and therefore, the role of people in land degradation and environmental rehabilitation was not perceived as a central issue. But although the dry biophysical context had a major impact on the environmental literacy and the environmental activities of the local people, also the powerful impact of social context became apparent during the study.

## 6.4. Effect of social context on decisions concerning environmental activities

### 6.4.1. Gender and environmental activities

The theory presently used proposed that both biophysical and social contexts have impacts on how local people manage their environment, affecting their choice of environmental activities. Moreover, it was assumed that these contexts often affect people's environmental practices as conveyed through their environmental literacy; by interacting with their biophysical environment and with other people, people acquire literacy in their environment, concerning, for instance, the use of trees.

Sometimes, people may be nonetheless obliged to "disregard" this literacy due to their poverty and livelihood needs (chapter 2.5.). Such an impact of the social context on environmental practices was present in this study in the case of fuelwood trade; although the local people perceived the trade as an important cause of decrease of trees, intensive cutting of wood for trade was nevertheless conducted by the poorest people for them to survive.

The present theory further argued that a social context includes several elements which affect local people's decisions of environmental activities, including politics (use of power) and economic circumstances, population growth and culture. Culture was perceived to affect people's behaviour in the form of cultural environmental

knowledge (learned locally from other people), which the theory assumed to often form an important part of the environmental literacy in tropical rural communities, although not the only "building block" of environmental literacy (chapters 2.2.5. and 2.5.). Such cultural knowledge is received from other members of a rural community, often including family members. It had been developed during generations in conjunction with people's experiences of their biophysical environment (Ellen and Harris 2000, 4-5; Martin 2003, 5). and therefore, it is also greatly modified by a particular production system of a community. The other cultural factors that were assumed to affect the local environmental practices included religion and gender (chapters 2.2.5 and 2.2.6).

The central role of precipitation causing environmental changes in the study area was an idea the nomadic pastoralists and the farmers had not only observed themselves but also heard from other community members since their childhood. In this sense, it was cultural knowledge. As a whole, the cultural, environmental knowledge seem to form the main "building block" of the environmental literacy of the nomadic pastoralists and the farmers. The nomadic pastoralists expressed rather homogenous environmental literacy in the uses of trees and also reported that they had learned about these uses from other community members (chapter 5.4.5). Moreover, also the farmers' environmental literacy in local trees and farming practices in the study area consisted mainly of such cultural, environmental knowledge, but the interviews also revealed environmental acquired from people outside the study area (chapter 5.8.3).

The socially constructed gender did not determine how the people perceived and addressed environmental changes, although it had an effect on their environmental literacy. In the interviews, the clear impact of gender on environmental literacy was present in some young women's answers. These women had moved recently to the area as a result of marriage and, consequently, could not describe environmental changes that had taken place there over the course of time (chapters 5.3.1. and 5.7.1). Another gender-affected characteristic in the local environmental literacy found in the interviews, was the pastoralist women's descriptions of the uses of the trees that they valued. Women were expected to take care of their attractiveness, which had resulted in these women valuing especially the cosmetic uses of trees. This environmental literacy included the use of several trees for colouring the skin and for acquiring an attractive scent with the "fuming" practice (see appendix. 4.). This type of gendered knowledge has been also found elsewhere – it has even brought the pastoral women economic benefits in south-western Namibia, where women have used aromatic plants to prepare perfumes, which they have sold (Sullivan 2000, 142-143).

It is also highly likely that both pastoral and farmer women had additional gender-specific environmental literacy (for example about plants they used for cooking), although such knowledge was not identified in this research. Pastoral men, on the other and, had specific knowledge of such plants that affected their animals. To a limited extent, this type of knowledge was also identified in this study (see chapter 5.3.1.). Hence, it seems that a study that would have concentrated more profoundly on research about how the gender affects environmental literacy would have identified more gender specific characteristics in local people's environmental conceptions.

As a whole, *whether a person was a women or man did not play a central role determining how environmental degradation and its mitigation in the study area were perceived*. This finding disagrees with widely critiqued, biologically-based ecofeminist ideas of women as "inherently" more protective towards the environment, which have been presented for instance by Vandana Shiva (see the critical positions taken by Jackson 1993, 390-399; Braidotti et al. 1994, 8; Sturgeon 1999, 257-258; Buckingham 2004, 147). The local women were not more protective and rehabilitative towards the environment than the men. In fact, the women were generally even more doubtful about the power of humans to address the environmental changes than men, but also in both groups variable views of the local environmental interaction were expressed.

Although not determining how the local people perceived environmental changes, *gender had nonetheless an important impact on women's and men's environmental practices via the gender-based division of tasks.* Pastoral women affected the environment mainly by the cutting of wood, while pastoral men affected the environment most of all as the principal livestock managers and cultivators. The farmer women affected the environment mostly by cutting firewood and by cultivating.

Gender had also a major impact on the power allocated to a person to make land-use decisions. Among the pastoralists, the men were seen as the decision-makers in the family and in the community, as those who held the decision power over household migration patterns, household economy and family croplands. Hence, also the families and communities which now spent a longer time in the study area with their animals than they did before, had changed their migration patterns as a result of men's decisions. It needs to be noted, however, that although the men were the final decision-makers on these matters, they commonly discussed the matter with their wives during the decision-making process (chapter 5.2.2).

Most importantly, it needs to be, however, recognised that *the pastoralist men made their livelihood-related decisions in a certain biophysical and social context that limited the*

*availability of strategies for maintaining their livelihood*. This context included, for example, environmental factors such as the scarcity of precipitation (Olsson, L. 1985, 103; Meteorological Department 2002) and a cultural context where nomadic pastoralism was for pastoralists learned production system and way of life, in which gender allocated them certain daily tasks. Moreover, the economic context in the study area provided them opportunities to maintain their livelihood there – a situation which will be further discussed later in this chapter.

Compared to nomadic pastoralists, the farmers had a less clear gender-based division of tasks. The farmer women and men conducted mainly similar agricultural practices. The only differences that were found were connected to the gum arabic production, for the gum was normally tapped by men, while the women and children collected the gum (which the men then normally traded). But even this division of tasks was not rigid and also women had tapped the gum (chapter 5.6.3.).

In female-headed households and families with young heads of household who had migrated to work outside the community, the women also decided on cropland use. Many women also independently managed small croplands they had inherited from their parents. The use of most of the cropland was, however, decided by the male heads of households who hence were, according to gender, perceived as the most capable of taking such decisions – after they often had consulted their wives. Similarly to nomadic pastoralist men, they also considered their land-use decisions in the social and biophysical contexts in their home area. All in all, *gender thus allocated the farmer men most of the land-use decision-making power, but these decisions were greatly affected by the social and biophysical context of the study area.*

### 6.4.2. The effect of religion

The Islamic religion was an integral part of the lives of the rural people included in this study. Religious conceptions were expressed in connection with describing environmental changes in several interviews in which God was emphasised as determining the precipitation in the area. The power of God over rain was emphasised in order to strengthen the argument that local people could not address themselves the precipitation caused environmental changes in the area (chapters 5.4.1 and 5.8.1.).

Hence, recognising God as the regulator of precipitation strengthened people's rather doubtful expressions concerning the significance of their own efforts to rehabilitate the environment. But perhaps more importantly, there existed certain characteristics in the social context that had affected the local people's doubts about

their abilities to make changes in the biophysical context they lived in. Most of all, people perceived environmental protection and rehabilitation on common property land as problematic activities, for they could not trust that others would participate in such activities as well: For example, unless a tree planted on common property land was guarded, there would be a danger that others would cause damage by cutting it for firewood or letting animals browse its twigs (see chapter 5.4.1). Furthermore, people had to think carefully about how to allocate their labour in order to earn their immediate livelihood in the area. In this situation, environmental rehabilitation as a goal of its own was not prioritised.

From a more holistic perspective, it can be perhaps pondered whether the limited faith that people had in their own power to change their biophysical circumstances reflected their restricted possibilities of changing their lives in general. People (and particularly women) had limited social mobility in their society; nomadic pastoralists were normally illiterate and the farmers commonly lacked opportunities beyond basic education. Few had also wealth that could provide them investment opportunities for empowering them with business activities. The women, who had been most doubtful about the role of people in addressing environmental changes, had generally even less social mobility than the men, since they had less decision-making power over economic and other family matters.

### 6.4.3. Impacts of policies and economic context on pastoralists 'environmental activities

Pastoral men's decisions on livelihood strategies and household migration patterns were affected by the Sudan government's policies and the economic context of the study area. In Sudan, as in several other African countries, nomadic pastoralists have faced a situation where their economic circumstances have deteriorated as a result of government policies that have favoured sedentary farming and perceived it as a more modern production system as compared to nomadic pastoralism (Manger 2001, 21; Casciarri 2002, 34).

In Sudan, the still currently valid, revised land law of 1970 ("Unregistered Land Act") left the Sudanese pastoralists' traditional property rights (and farmer's traditional village lands) officially unrecognised. This had made it hard for the pastoralists to defend their property rights, particularly since the government has had a tendency to support sedentary agriculture rather than nomadic pastoralism; as a result, many former pasture lands have been taken for agriculture by the government and private cultivators. This increased privatisation has decreased pastoralist mobility and access to pasture and water on their traditional pasture

lands. Government's campaigns for digging wells and *hafirs* by mechanical means have also resulted in the exhaustion of pastures through overstocking in some areas. Moreover, the pastoralists have been obliged to adjust their production activities to the needs and consumption patterns of the sedentary population and to international markets in a situation where the prices paid for animal products had been disadvantageous for pastoralists (Casciarri 2002, 34).

The interviews suggested that particularly the large market for cow milk in El Obeid was an important factor that caused camel pastoralists to buy cattle and the cattle pastoralists to modify their migration with the result that that they spent longer periods in the study area than before. Moreover, it seems that the El Obeid - Khartoum tarmac road that was built in 1990 has increased investments in livestock (by locals, urban traders and government officials), which also has contributed to the environmental degradation in the study area (UNDP 2003).

In Sudan, the livestock marketing system functions via three main stages, including the local level (small primary markets where the process of stock collection begins), a secondary market at the provincial level and the terminal markets (Nur 2001, 3). El Obeid has the largest secondary market for livestock in Sudan. Partly owing to the many traders in the marketing chain, small producers have received low prices for their animals. Another reason for low price, has been the troublesome and long transportation route for taking the animals to the terminal markets, during which large distances are often passed on the hoof (World Bank 2003, 96-97). In addition, the quality and availability of pasture has also affected the conditions of animals and consequently the price paid for them.

The Sudanese government has also influenced the trade with specific livestock policies. The government designed for the period 1992-2002 a general ten-year development plan ("Comprehensive National Strategy") that also included the development of the livestock sector. The goals were ambitious and export-oriented, including for instance increasing the livestock export twenty-fold, tripling the livestock population and the eradication of endemic and epidemic animal diseases (Nur 2001, 1-2). Previously, five major traders dominated the export of animals, but the situation was changed by the government at the beginning of the 21st century by giving one trader a monopoly over export. This decision has been described to particularly affect the poorer small-scale producers who suffer the most from the weakened competition and lower prices paid for their animals (World Bank 2003, 96).

The livestock trading opportunities in the El Obeid area and the market for cow milk in the town has, nonetheless, attracted the pastoralists into the study area. In

addition, government policies have also been a factor that has "pushed" them away from certain areas. Particularly some *Hawazmas* have lost grazing areas due to large agricultural schemes established south of the study area. Another issue that has hindered *Hawazmas* migration in the South has been also the long civil war (Salih 1990, 63-64), which was also brought up in some of the interviews of this the present study. Aside from the trade in livestock, milk and fuelwood, the interviewed nomadic pastoralist households had not benefited economically from urbanisation. Some pastoral men had, nonetheless, found employment in towns, for instance in El Obeid. Nevertheless, from the perspective of the nomadic pastoral women, this employment have not necessarily provided the expected income for their households, since the men had often established new families in towns.

The pastoralist women were involved in petty trade such as selling handicrafts or sugar and tea bought from towns (chapter 5.2.1.) Women used to play a particular role in making furniture, particularly beds, but the expansion of monetary economy had diminished this activity (chapter 5.2.1.). The impact of the growing monetary economy has thus been partly positive on the environment, since, for example, buying metal beds had decreased the pastoralists' cutting of trees for making beds. However, it seems that the negative consequences of the increasing monetary economy might outweigh its positive impacts on the environment. A main issue is the large market for fuelwood in El Obeid and elsewhere in the area (combined with the poverty of pastoralists) that has lead to intensive cutting of trees.

The pastoral households affected the environment in the study area in variable ways. The theory assumed that poverty can cause environmental degradation, but it was also assumed that wealth may contribute to unsustainable environmental behaviour (chapter 2.2.1.). This study identified an impact of both the poverty and the wealth of the nomadic pastoralists on the environmental degradation in the study area. Wealth had increased the environmental impact of some pastoralist families, since large herds of animals naturally affected the environment more than smaller ones. The environmental impact had also been intensified by their decisions to herd the animals in the El Obeid area longer than before owing to the market opportunities. Simultaneously, as already described, poverty had also contributed to the environmental changes, for the poorest families had been obliged to cut trees in order to sell fuelwood.

Increased economic differentiation and social stratification have affected nomadic pastoralists in Sudan and in many other societies (Fratkin 1997, 236; Manger 2001, 22) and also in this study, considerable differences in the economic status of nomadic households were disclosed. Although large herds of animals of the wealthiest pastoralists had caused the most severe impact on the environment in the

study area, they themselves suffered least from the environmental degradation, since even during droughts they had been able to purchase the commodities they needed, food items and charcoal. During droughts, the wealthy pastoralists had also been able to buy animals from the poor in low prices (UNDP 2003).

The poorest pastoralist households suffered most from land degradation. They had been obliged to sell their camels or cattle in order to survive, and their livelihood depended on some small ruminants and, perhaps, a small plot of cropland, added to other available sources of income such as petty trade. When drought occurred, it became increasingly difficult to get harvests from their small croplands plots, and they had to rely more on other available sources of income. In this situation, their cutting of trees for the fuelwood trade was likely to increase. The decrease in the stock of trees made it, in turn, even more troublesome for them to collect firewood, which affected the daily lives of women.

### 6.4.4. Effects of policies and economic context on environmental activities among farmers

The land use decisions of the farmers were affected by the government policies and the economic context. Although farming was the main source of livelihood for the farmers, the households normally had several sources of livelihood such as the income earned from working outside the study village (mainly in Khartoum). Men inherited most of the farmland, although women had also inherited some agricultural land, and some land was also rented or bought from others. The land allocation system was still principally traditional, where in practice the *sheikh* held most of the power to allocate village land – although, during the course of time, the areas of village lands not yet allocated to individual farmer families had diminished (Kevane 1997, 297). Moreover, it seems that the *sheikh* was not always considered as an authority whom the villagers could not oppose in rent collection (see chapter 5.6.2).

In the households, economic considerations affected what was cultivated, although, as discussed before, many other factors also affected the decisions on cropland use. The unpredictable precipitation made it challenging for the farmers to make economically optimal land-use decisions each year. In the past, their situation after the drought had been made worse by local merchants who had speculated on food crop prices; for instance, in 1984 and 1985 the prices of sorghum sky-rocketed (chapter 4.2.; Olsson 1993b, 401- 402). To minimise the risks caused by the unpredictable precipitation, the farmers grow different crops even on small agricultural plots. They were not able to leave everything to depend on one type of

crop, they needed to minimise the risk of hunger and to see how various crops produced each year; if one crop failed, another crop would perhaps do better. Farmers' use of several sources of income (see chapter 5.6.1.) was another important strategy to address the risks in maintaining their livelihood in the study area. This livelihood strategy of diversifying the sources of income has also been important elsewhere in rural areas of such in northeast Nigeria (see Mortimore and Adams 2001, 55).

In the study area, the use of land for cash crops was affected by market signals. For instance, it seems that the large areas allocated for the *karkadeh* in 1992, can be explained by the high prices that were received from the crop in the preceding year (El-Dukheri 1997, 22). It has also been pointed out that the farmer households in the study area have to meet their basic and other household needs by growing agricultural crops and generating a sufficient income (El-Dukheri 1997, 24-25). To be able to meet these needs, a farmer household selects between various livelihood activities such as crop cultivation, livestock management or gum production.

This study also perceived the rural people as actors who make choices on how to use the land, but it is at the same time stressed that the *social and biophysical context of the study area strongly regulated and limited their options for livelihood strategies.* For example, many interviewed farmers had lost their cattle after the great drought in the 1980s and had not bought new animals since: Such a situation that has previously been identified by El-Dukheri (1997, 7, 75) who studied other farmers in the study area. There are several reasons that could explain this choice of not to buy cattle, such as the obviously painful memory of losing herds due to the drought, the already large milk trade of the pastoralists in the area, and the challenge of finding suitable pasture for cattle in the reduced common property land. Poverty was another reason for not buying cattle. After losing their livestock, the farmer families had mostly relied on the piece of land they had normally inherited, often complemented by other small-scale income generating activities. In many families these sources of livelihood had enabled them to meet their needs, but perhaps not to invest significantly into expensive animals such as cows.

Furthermore, farmers had no means to borrow money at a decent interest rate. There was a traditional loan system in the area known as *sheil* (Olsson 1993b, 401; El-Dukheri 1997, 87), which was not mentioned in the interviews in the farmer village studied, although it was still common in the area (Gaafar Mohamed 2002, personal communication; see appendix 3). In this system, in order to get money for seeds and other necessities, the farmers commit themselves to deliver a certain amount of grain to the *sheil* merchant at harvest. The system is unfavourable for the borrowers, because the *sheil* merchants want to ensure themselves a good profit. As

a consequence, those farmers who had borrowed money from a *sheil* merchant tended to earn a low income from their crops. If the crops failed and a farmer was unable to deliver the required amount of crops, he would in debt as well as suffering from the lack of food (Olsson 1993b, 401).

The prices that the local farmers had received from their crops had also been diminished by the involvement of several merchants in the marketing chain, each taking their share of the profit. Similarly with the livestock market system, also the crop trade in Sudan had three levels, including the local level, the provincial level and the national level. The farmers sold their crops locally in their village markets or in the nearest towns, where the merchants bought their products. The exported crops were normally taken to El Obeid, where they were registered by authorities and perhaps sold further to another merchant. The exported crops were then taken to the terminal markets (El-Dukheri 1997, 87; Gaafar Mohammed 2004, personal communication; see appendix 3).

Of the various farm products, gum arabic is most actively monitored by the government. Globally, Sudan is the largest producer of gum arabic, making approximately 80% of the gum (Iqbal 1993; Seif El Din and Zarroug 1998). Each year, the government-managed (partly government and partly privately-owned) Gum Arabic Company (GAC) sets a minimum price for gum that the buyers are required to paid in the gum auctions organised in El Obeid. Either the GAC or licensed buyers buy the gum in these auctions. The Sudanese traders were not allowed, however, to export the gum themselves, but had to sell it to the GAC which exported it (Seif el Din and Zarroug 1998, World Bank 2003, 97-98).

The GAC trade was, in turn, affected by the international gum arabic markets. In the 1970s and 1980s, the demand for gum arabic decreased drastically in the international markets and the use of synthetic substitutes increased. Gum arabic was expensive at the time, owing to the extensive droughts in Sudan and elsewhere in the Sahel area that had led to a reduction in gum production. Later, the increasing gum arabic supply boosted its demand in the international markets and lately, significant replacement of gum arabic with substitutes has not occurred (FAO 2004, 42-43).

As a whole, the land use of the nomadic pastoralists and the farmers was affected by the economic context that had extended from the local to the international level. The nomadic pastoralists and farmers lived in households with varying economic situations and differences in wealth, which affected both their impact on land degradation and its significance for them. Poverty among farmers had led them to conduct harmful activities in the environment, since the poorest families needed to

use their cropland intensively, without long fallows, in order to survive. They had small, often rented, plots and the poor female-headed families often lacked adult men that could provide additional income, for instance, by working in Khartoum. In addition, they were obliged to trade fuelwood, which required intensive cutting of trees. Since the poorest families depended that significantly on the natural resources of the study area, they also suffered most from environmental changes such as the decrease of tree cover and cropland production. The wealthier farmer families had more (inherited) land and male members who could earn additional income from working outside the village.

### 6.4.5. The effect of population growth

Paul Little has proposed that the *uneven population distribution* that is made worse by excessive population concentrations around mechanised borehole wells and small towns has caused land degradation in many pastoralist regions (Little 1994, cited in Fratkin 1997, 242). Hence, it seems that rather than population growth as such, the distribution of population and its concentration of population in certain areas might be even more important as a factor causing land degradation. An increased concentration of the pastoral population had also occurred in the study area, particularly owing to the trading opportunities in El Obeid area and the availability of water in wells and *hafirs*.

As previously mentioned in this chapter, population growth had nonetheless caused a decrease of the size of inherited cropland plots among the farmers. This was one of the factors causing increased poverty and particularly significantly so in the female-headed households with a small inherited cropland plot or no owned land at all, having no adult males in the household who could earn additional income by working outside the community. In these families, the need to earn a livelihood seems to have led to degrading environmental practices such as cutting trees for trading fuelwood and cultivating agricultural lands intensively. The diversification of income by male migration and other economic activities, however, alleviated the impact of population growth in the majority of farmer families.

## 6.5. Women's choice on environmental activities

Thus, numerous biophysical and social factors had affected the local people's choice of environmental activities and consequently their role in land degradation and environmental rehabilitation in the study area. Therefore, when the focus of attention is turned particularly on women's decisions about their environmental activities, a wide perspective needs to be taken where women are seen as part of the biophysical and social context. Next, applying the summary of the theoretical framework explained in chapter 2.7., the women's choices on environmental activities in the study context is presented in two figures. Figure 12 summarises the factors that had affected the *pastoral women's choice on environmental activities* and Figure 13 presents the summary of the *farmer women's choice on environmental activities.*

The figures organise the factors affecting the women's behaviour under separate headings such as culture, to present them in a visually clear and understandable manner. It needs to be noted, however, that the factors that affect the women's choice of activities are intertwined. For example, gender is a cultural construction that has affected how women and their capabilities were perceived. It has had an effect on multiple issues such women's daily tasks, their environmental literacy and their economic decision-making positions in their families.

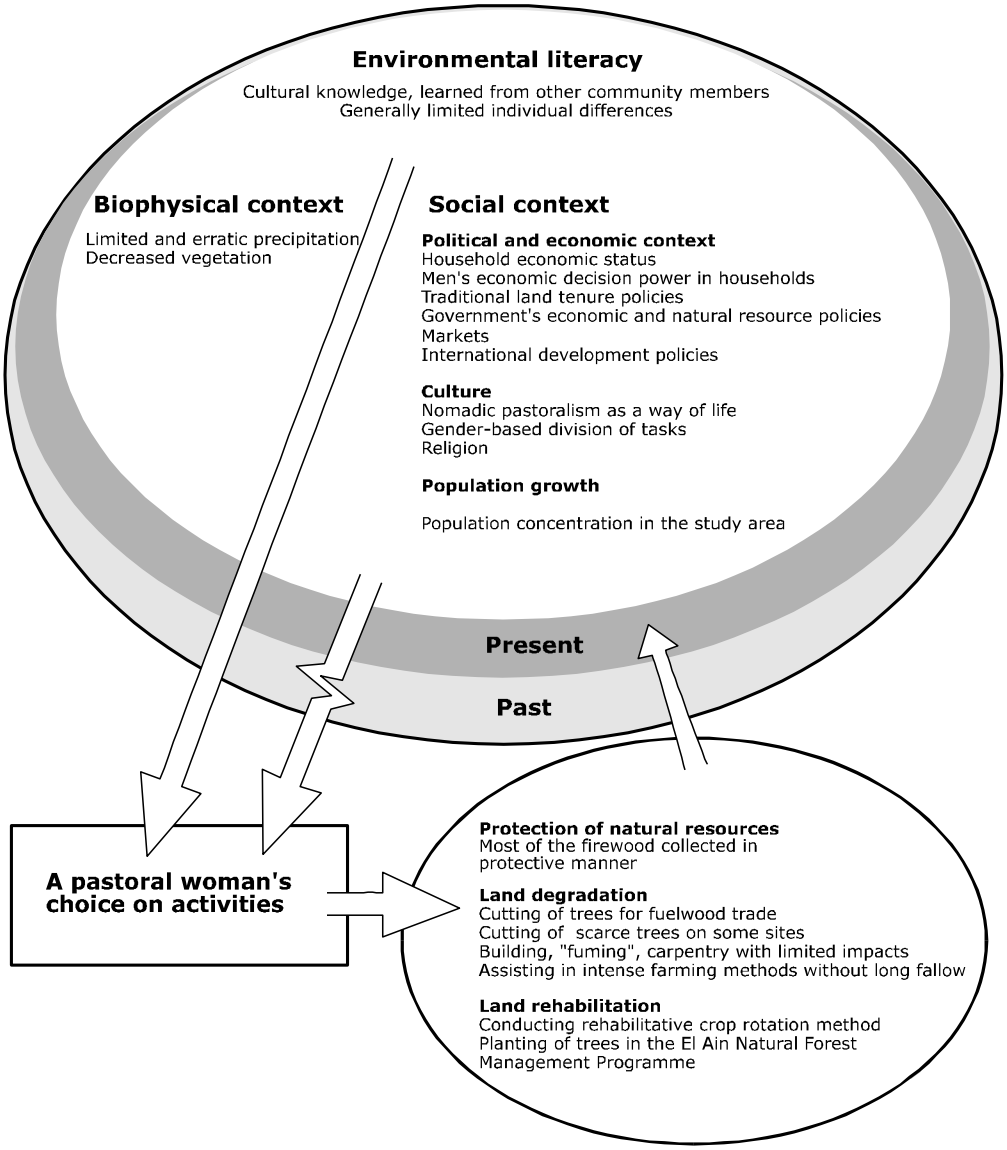


Figure 12. A pastoral woman's choice on environmental activities

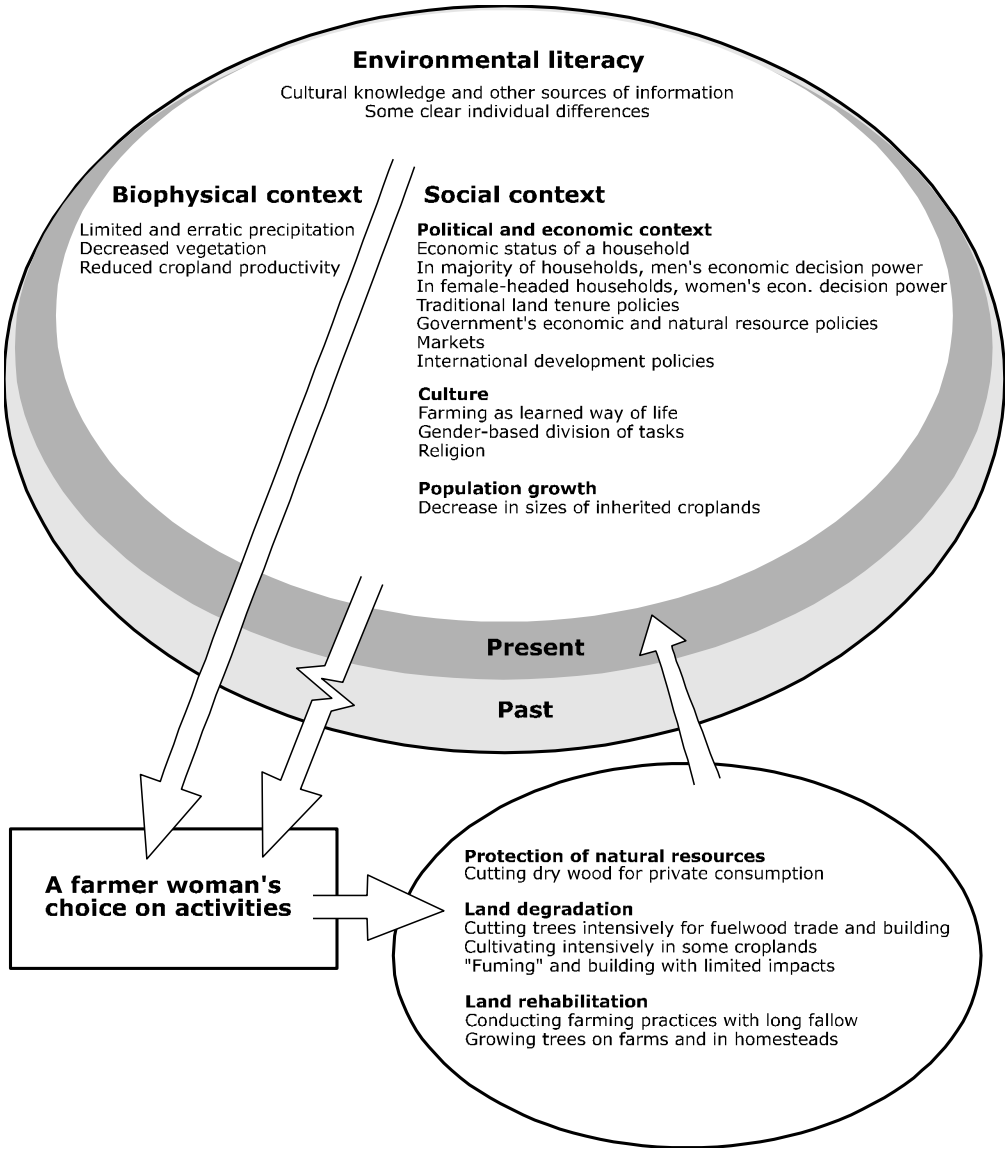


Figure 13. A farmer woman's choice on environmental activities

Hence, the rural women affected the environment in the study area with their livelihood-related activities. The environmental impact of women's activities varied, depending, for example, on the time that they spent in the study area each year and the economic status of their households. Mostly, the women seemed to have affected the environment as fuelwood collectors. Nevertheless, when one considers the particular roles of women in land degradation from a holistic perspective, it

becomes questionable whether they can be perceived to have played roles at all. This is because gender and the gender-affected decision power in families, poverty and the need to maintain a livelihood in the area had caused them to conduct environmental activities that appeared to be harmful to the environment. However, *they have had no power to change these causes of their harmful practices*.

## 6.6. Gender-sensitive environmental intervention: participation, joint learning and adaptation as guiding principles

From the beginning of this study, its findings were assumed to provide such knowledge of the study context that would be beneficial in designing a gender-sensitive, forestry-related environmental rehabilitation programme in the area in question. This sub-chapter discusses the findings of this research and presents some ideas and suggestions for a forestry-related environmental intervention that could be implemented in the study area.

Furthermore, some perspectives based on the outsiders' development discussion and on experiences elsewhere are believed to be beneficial in designing an appropriate and gender-sensitive environmental intervention. The most important idea that is adopted from development discussions and experiences from elsewhere is that of local *participation*, which outsiders such as researchers, development professionals and activists, have emphasised for decades. In brief, the idea of participation refers to respecting local views and involving the local people in development activities (see Chambers 1983; Chambers 2004, FAO 2005b). The gender aspect, recognising the importance of ensuring that both local women and men participate and benefit from the development activities, has been also commonly recognised as important in international development efforts (e.g., Braidotti et al.1994, 82-83; FAO 2003).

Outsiders have created numerous terms to describe participatory approaches which have been applied to development activities. In forestry-related development, various terms such as social forestry (Poffenberger 1990), community forestry (FAO 1989), joint-forest management (Sarin 1995) and collaborative adaptive forest management (CIFOR 2003) have been used to describe and implement approaches with local participation. From the ideological point of view, the numerous participatory approaches have a lot in common as they all emphasise the crucial importance of local people's participation. The approaches have also commonly used PRA methods (or PLA methods as they were called by Pretty et al. 1995) either to collect information time-effectively and yet, in a participatory manner, or to implement project activities such as awareness raising. Two PRA exercises were also

included in the present research, so as to provide complementary information on the farming community studied (see chapters 5.6.2. and 5.6.3.).

Although the various participation approaches are rather similar in their basic ideas, they have also undergone some modifications over the years. For instance, instead of discussing communities, some current approaches use the term "stakeholder" (e.g., CIFOR 2003, FAO 2005b). Discussing the stakeholders rather than the communities shows that it is understood that communities include various people and interest groups who may have differing development needs; this approach is hence compatible with the idea of gender-aware participation that is sensitive also to women's needs.

The Collaborative Adaptive Management approach (CIFOR 2003) also stresses that local and other stakeholders such as governments or NGOs need to manage the natural resources in *cooperation* and that this collaborative management would need to be able to accommodate various stakeholders' interests. Furthermore, developing the management of forests and other common property land is perceived *as a process including joint learning* from the experiences in collaboratively managing the natural resources. Based on learning from experience, the joint management of natural resources (such as a forest area) can always be developed and hence, a flexible management is capable of adapting to local circumstances (see CIFOR 2003).

Here, the importance of collaboration and adaptive management is also underlined. Adaptive management requires sensitivity to the contextual conditions, recognising that political uncertainty, institutional capacity limitations, financial constraints, existing power relationships and diverse views on the local land users affect the implementation of environmental interventions (Armitage 2003, 79). Thus, even thorough studies of various contexts cannot predict all challenges and occurrences that the implementation of an intervention will face (see also Walters et. al. 1999, 211). Therefore, although this study report provides some perspectives and suggestions for an environmental intervention in the study area based on the research conducted, it needs to be also recognised that complexity and *changes in circumstances* tend to be part of human life in many areas.

## 6.7. Suggestions and perspectives for environmental intervention in the study area

### 6.7.1. Food problem and some measures to raise the productivity of croplands

This study recognises and emphasises that participatory, gender-sensitive forestry-related intervention in the study area would need to be based on local perceptions of

the most urgent needs in the area. Although the local population included people with a varying economic status (chapters 5.2.1. and 5.6.1.), the interviews suggested that the insufficiency of food was a more or less permanent problem for the poor families during droughts, and a problem for many other families as well. It is hence suggested that an *environmental programme in the study area would need to prioritise alleviating the problem of shortage of food.*

Hunger is a problem connected to the difficulties in earning livelihood in the study area, which could be alleviated to some extent with technical measures to address the low productivity of croplands. Increasing of land productivity is not, however, solely a technical issue, for it requires policy decisions to decide what methods are promoted. These decisions are affected by the knowledge, values and prioritisations of the political decision makers, government officials and international donors. Mostly, the choice of methods would nonetheless have to be affected by the needs, priorities and practices of the local farmers. An important choice to be made is whether to promote an increased use of chemical fertilizers and pesticides. The limited promotion of chemical fertilisers by Sudan and other developing countries have been criticised from the poverty perspective, emphasising that the local farmers are able to use chemicals appropriately and that they have a right to access to chemical fertilisers and pesticides for improving their crop productivity (Morton 1996, 123-124).

Here the use of chemical fertilisers (and pesticides) is nevertheless viewed as a more problematic matter and particularly so under dryland conditions due to their economic and environmental risks. In terrestrial ecosystems, the use of chemical fertilisers, specifically if used in unbalanced manner, may cause a decline of plant species and micro-organisms that have adapted to a low nutrient supply (Ayob 1999, 117-118). In dry regions, nitrogen-rich fertilisers have also been found to lead to soil acidification, which has reduced long term cropland productivity (Dougil et al. 2001, 202).

A key issue that makes the use of chemical fertilisers particularly problematic in drylands is the limited and erratic precipitation, for during drought no fertiliser additions would be able to save the damaged crops. The risk of droughts makes the use of chemical fertilisers as an economic risk for farmers, an investment that might not result in the intended production increase even in the short term. Drought may also destroy the benefits expected from the use of pesticides, which also include environmental risks. For instance, in China, heavy use of pesticides has led in some areas serious health problems among farmers, land degradation and increased level of chemical residues in the national food supply (see Huang et al. 2002, 55).

Thus, although the issue of lack of food was raised as the most urgent problem in the study area, the promotion of an increased use of chemical fertilisers and pesticides is not suggested. Instead, an increase in the use of organic fertilisers may be more beneficial. The practice of using organic fertilisers is familiar to the local farmers who already use agricultural residues and animal manure to fertilise their lands. Some have also used the *guar* cover plant (*Cyamopsis tetragonoloba*) to increase their cropland productivity with positive results (chapter 5.8.1.). Hence, it seems that supporting an increased use especially of leguminous cover plants to fertilise the croplands be one way to increase agricultural production (see Danso et al. 1992; Räsänen et al. 2001).

Since positive local experiences of such a plant already exist, sharing of these experiences might also motivate experimentation by such local families, who might otherwise feel hesitant to try them. Whether the use of animal manure could be increased in the area by collecting it more systematically on common property land is an issue which could be worthwhile to study further. Using as many organic means as possible to increase the productivity would most likely lead to the most effective results.

Some farmers also already knew how to use the locally widely-grown *neem* tree (*Azadiracta indica*) as a source for pesticide (chapter 5.8.3.), a practice that also could be supported with extension work. Another issue to examine further would be erosion control. The farmers already commonly cultivated *Acacia senegal* in their farming systems, which partly addressed the soil erosion problem. Some cultivators had also made live tree fences around their croplands, which had protected the croplands against wind and also marked the plot boundaries. Much agricultural land was, nonetheless, exposed to wind without protection by fences. Whether an increase of fence construction against wind and, particularly, maintaining such fences would actually result in enough erosion control in the harsh conditions of the study area to make the allocated labour worthwhile, would need to be further discussed with the local people.

Earlier forestry-related studies of the area also suggest that the production of gum arabic could be increased by using certain, optimal tapping technique and frequency (Ballal 2002, 93). Whether this knowledge would be beneficial and applicable for the farmers in practice could be further explored by discussing with them. When judging the urgency of such activities it should be considered that the poorest farmers do not earn income from gum arabic or they earn in some cases a marginal income from few trees. Therefore, the development of the gum arabic production would not significantly affect the hunger problem among the poorest households. Nevertheless, there is a general need to raise the productivity in croplands and also

many of the "middle income" households struggle to maintain their livelihood during years of limited precipitation.

The gum yield can also be increased when *Acacia senegal* is interplanted with agricultural crops such as sorghum and *karkadeh*, rather than growing trees in separate plots (Gaafar Mohamed 2005, 75). However, *when the agricultural crops are interplanted with A. senegal*, *their yields decrease*. Therefore, especially during years of low gum arabic price and high price of agricultural crops this intercropping would not be economically beneficial for the farmers (Mohamed 2005, 75). Relying more on one cash crop such as gum arabic, at the expense of other crops (including also food crops), would add to the risks of maintaining a livelihood if the gum arabic prices suddenly fell. Since the local farmers try to minimise the risks associated with crop failure by growing several crops and food crops in particular, this change of management does not seem to be in their interests.

Moreover, as described in chapter 5.7.2. and chapter 6.3.uncontrolled fires in faming systems had also affected the environment in the study area, including the gum gardens. Thus, although the local people have witnessed damages caused by the fires, they have sometimes exercised insufficient control of fire in their farmlands. There can be many reasons behind this insufficient control (such as the heavy labour burden of women) and, therefore, it seems that prevention of uncontrolled fires with local participation would be possible only if information is acquired of the *exact circumstances* in which the fires have occurred. This information can be acquired from the local people, who might also have ideas of the appropriate local measures to improve the fire control. Furthermore, it needs to be noted that community based fire control activities have been conducted elsewhere such as in Burkina Faso (see Penttinen 2002) and perhaps similar type of activities could also tried in the area studied – but only in the case the local people perceive them as appropriate in their home area.

Technical measures also exist to increase the production of pasture lands in the area, such as introduction of new, particularly drought-tolerant grasses and forage trees (Mainguet 1994, 204-206). Implementing such measures successfully would be, however, extremely challenging and their environmental impact perhaps rather limited. Property rights of nomadic pastoralists are not clearly acknowledged by the other stakeholders (farmers and the government), who would need to agree to allocate some sites solely for pasture development. Due to the scarcity of land in the study area, the pressure to use it for grazing, browsing and for firewood is so high that such land would need to be well guarded.

Furthermore, even if the development of pastures would be successful in some areas, the pastoral population concentration and the high number of animals are challenges that will not cease to exist as long as keeping of animals is encouraged by the water sources and the markets for herded animals and their products. Hence, allocation of resources to rehabilitate pasture lands is not suggested. Rather, it would be more realistic and effective to diversify the pastoralists' sources of livelihood and concentrate on protection activities.

### 6.7.2. Need for income generation

Perhaps the most effective development programme activities to protect the common property land would be to provide the poorest pastoral and farmer families income-generation opportunities, since they are currently obliged to harvest much fuelwood for their income. Moreover, specific support allocated to the poor to earn income (such as micro credits), could perhaps also help them to *gain increased control over their lives* and hence, empower them (see how Page and Czuba 1999 perceive the term empowerment).

As brought up in chapter 2.2.5., the GAD approach has supported the idea of equality between women and men (Braidotti et al. 1994, 82). Therefore, it tend to favour to the idea of empowering women. Nevertheless, when the empowering is considered, it needs to be noted that although the rural women had a lot in common as a group, they also had varying positions in their communities and their families. The poorest female-headed households in the farmer community relied for their livelihood on rented cropland and did not receive additional income from men working outside their village. The wealthiest farmer women of the same community lived in a household that cultivated inherited, much larger croplands and they had other sources of income received from men in their families and from several businesses (chapter 5.6.1.). Among the nomadic pastoralists, some women lived in households which owned tens or even hundreds of valuable domestic animals (camels, cows or both), when the poorest households had lost all their valuable animals and relied perhaps on a small, rented piece of land (chapter 5.2.1.). Hence, it would seem appropriate and justified to target the support for increased income-earning capacity particularly to the poorest and most vulnerable, including the poor female-heads of households in farmer communities and the women in the poorest pastoral households.

Designing and implementing successful local income generation would be a demanding task in the study area where the natural resources are scarce and people earn a limited income to buy products. There is nevertheless a lot of petty trade in

the area, and further discussions with the local people would provide ideas for designing and implementing concrete, perhaps rather small-scale, but nevertheless income-generating activities. In connection with each locally suggested product a particularly important issue to consider would be the robustness of the existing market; i.e. whether there is a sufficiently interests and money to buy the products so that they would generate the needed income.

### 6.7.3. Trees in environmental development: issues to consider

The development of local income generation could also be related to environmental rehabilitation activities such as planting of trees. The local trees would provide numerous possibilities for income generation by using and developing their non-wood products: for instance, fruits or juices, medicines, colouring and perfumes could be sold (see appendix 4 for the uses of local trees). The previously-mentioned issue of markets would nonetheless also need to be considered in connection with these products. For instance, this study revealed that although "fuming" was widely practiced in the study area (chapters 5.4.3. and 5.8.3.) and perfumes could be manufactured from local trees, industrially-produced perfumes, sold in attractive glass bottles, were bought by those who could afford them. Locally-produced perfumes would perhaps not easily achieve the same status as luxury item.

In addition to the need for income, there are several other issues that have to be considered in conjunction with planting of trees. The limited precipitation is a major issue and it requires *women's labour* to fetch the water. Therefore, although the farmers are familiar with growing trees on their own lands, the farmer households cannot be expected to grow voluntarily on their private lands seedlings that need to be constantly watered. In fact, particularly during droughts even the requirements of small quantities of water may cause a problem, resulting in the loss of seedlings.

Planting trees on the common property land would require negotiations with all the stakeholders, including also the nomadic pastoralists who would need to accept this activity and be given the opportunity to participate and have their property rights well defined in the rehabilitated area. It should be also recognised that it takes time for the trees to grow and therefore they do not provide immediate benefits, which is why the people participating in tree planting on common property land and allocating their labour to such practices, would need to be compensated in the short term for their efforts. One option could be to let the tree-planting families also cultivate agricultural crops in the rehabilitated areas or supply them with incentives in the form of food.

The *Fellata* pastoralists included in this study have previously participated in some tree planting activities on common property land in the El Ain Natural Forest Management Programme where they had received incentives for planting such as flour and sugar. However, these incentives had negative consequences that became apparent in this research; similarly to others groups, the *Fellatas* lacked the enthusiasm to plant trees on the common property land. A *Fellata* woman stated even straightforwardly that she would not plant any trees without food supplies in return (chapter 5.4.2.). Therefore, it should be noted that providing incentives for rehabilitation of common property land may lead to lack of ownership of such activities and subsequent unsustainable development impacts. After the environmental programme is over the local people might not continue such activities on their own. From this viewpoint, one could be argue that no incentives should be provided.

Here, these ownership and sustainability concerns in connection with tree planting are acknowledged, but local needs and prioritisations are considered to be more important. The land users of the study area do not prioritise environmental rehabilitation as a development need and their labour is needed for daily tasks in earning a livelihood. Consequently, it is suggested that if some sites on common property land would be developed by local people, they should get some incentives in return such as food or the to right cultivate agricultural crops in some areas.

Secure land tenure has been raised as a factor that has been a pre-requisite for local people's participation in environmental rehabilitation activities such as tree planting (Amacher et al. 1993, 450; Walters et al.. 1999, 193-194). In the study area, many farmers are used to growing trees on their own lands and hence the idea and practice of growing trees is familiar to them. The central constraint is *labour*; farmers need to carefully consider how to allocate their labour in order to maintain their livelihood, and they cannot be expected to make considerable efforts in order to have more trees in their lands which do not provide immediate food or income. Therefore, the farmers' private planting could be perhaps most effectively increased by an easy availability of attractive, drought-tolerant seedlings. This study provided some information on the trees that the locals valued the most (chapters 5.4.3 and 5.8.3.), that could perhaps be utilised when choosing tree species for planting.

To strengthen the protection of trees on the common property land, fuel-saving stoves could be introduced. The stoves would also benefit the women by reducing the burden of collecting firewood. Most of the food was cooked in the area with an uncovered three-stone stove. Many families had also a charcoal stove, which they used rather rarely due to the need to pay for charcoal (chapters 5.2.3. and 5.6.3.). It therefore seems that an improved stove that relies on an energy source that the

people would not need to pay for has the best likelihood to be adopted in the study area. Introducing solar cookers is an option, which has already been promoted by various organisations and implemented in a number of projects during decades. However, although they are widely praised by manufacturers and developers, there are some issues related to solar cookers which perhaps partially explain why they still are not widely used and adopted by rural women in the tropics.

Based on the researcher's own two field assessments of solar cookers in a refugee camp in north-eastern Ethiopia in 1998 and 1999 during her employment with the UNHCR (United Nations High Commissioner for Refugees) and on a source evaluating a solar cooker project in Mali, some challenges related to solar cookers are here raised. Firstly, solar cooker manufacturing materials seem to pose a challenge. Locally available, low priced materials (e.g., aluminium foil that can be used to reflect the solar rays) tend not to be durable (see e.g. Niare 2005). Thus, the people are expected to appreciate the cookers so much that they would allocate efforts (and even money) for their frequent maintenance – without such efforts, the use of cookers will stop after they have broken.

If more durable and expensive materials were taken to the area from outside, the women would be able to use the cookers for a longer period of time. Eventually, these cookers would need maintenance as well, requiring a financial investment and, particularly, the *availability* of these needed materials (e.g., glass) to get the stove repaired and back in use. Distribution of durable solar cookers manufactured from costly materials to a large number of people would naturally also require a considerable financial investment from the donors.

Therefore, although recognising the solar cookers as a valuable innovation that may benefit vast numbers of people in the future, it is suspected that, in the study area, wide local adoption of these cookers and their permanent use could be currently problematic. The main issue seems to be connected to materials; it is not realistic to assume that the local people would allocate significant additional efforts and financial resources to maintain the cookers. Another challenge is the issue of integrating solar cookers to the local food and cooking habits, which might need to be changed with the solar cookers (see e.g., Niare 2005).

Owing to these challenges connected with solar cookers it is suggested that an improved stove that could be used with firewood would perhaps suit better the current circumstances of the study area. When choosing a suitable design, many issues would need to be considered such as the availability of local materials, who would make the stoves and how the stoves would we distributed.. Technical expertise on fuelwood-saving stoves exists, and the wealth of experience from

introducing various types of stoves around the world could support the design of such activities in the study area with local participation (see e.g., Westhoff and German 1995 about various stove types).

### 6.7.4. The significance of development and forestry policies

For political reasons, the international co-operation with Sudan was scaled down at the beginning of the 1990s, whereby numerous international development projects were terminated. International organisations have since worked to provide emergency aid, and NGOs have implemented projects. At the beginning of the 21st century, intensified international efforts to support the peace process between the North and the South of the country have provided hope that increased international cooperation to support Sudan's reconstruction and development would take place in the future. This restart of full-scale international development cooperation is needed as a prerequisite for increased donor-supported environmental intervention in the study area.

Hence, for years the Sudanese government had not received large-scale material support from international donors for environmental or any other development activities. Meanwhile, it independently developed the natural resource and economic policies based on the political leadership's priorities and available resources. This chapter has earlier presented how these policies have affected land use decisions of the nomadic pastoralists and farmers in the study area.

When the role of a particular forest policy is discussed, it needs to be noted that Sudan's forest policy in 1986 adopted the idea of local people's right to participate in managing the forests, and this right was even confirmed by a particular forest law, the "Forest Act" that was published in 1989. However, the law also allowed the governmental FNC the main control over forests, in cases where a forest was defined as a forest reserve (Abdel Nur 1989, 2). In 2002, a new forest law "Forests and Renewable Natural Resources Act" was introduced. It tightened the government's control over forest areas, since it was now clearly emphasised that FNC has an important role in protecting all forests against any kind of trespassing that might lead to environmental degradation (FNC 2003, 9).

Nevertheless, the inclusion of the idea of local participation in forest management in 1989 encouraged the launching of El Ain Natural Forest Management Programme in the study area. Thus, although the programme faced difficulties due to the conflicts between nomadic pastoralists and farmers over the farmer-managed forest areas, the programme was nevertheless an effort to implement participatory policies in forest

management and engaged also some nomadic pastoralists in tree planting (see chapter 4.8.2.) However, after the donor support to the El Ain programme ended, the project activities were practically stopped by the FNC due to lack of funding (Ali 2002, personal communication).

FNC has allocated more resources to support the tree planting by the farmers studied. Although the activities in the Restocking of Gum Belt for Desertification in Northern Kordofan programme were scaled down after the donor support ended, FNC has continued to work with farmers, particularly by supporting their increased cooperation in the gum arabic trade. FNC has also a small nursery in El Obeid, where farmers can purchase seedlings (Ramli 2002, personal communication).

At the same time, according to the current forest policies, FNC has the role of controller of the use of trees in the study area, including the trees outside the forests on the common property land. This role taken as a controller of the local use of trees and protector of the environment was also witnessed by the researcher at some occasions. For instance, the researcher observed a FNC employee chasing away a local man who was cutting the stem of a tree. Hence, it seems that although the need for local participation is recognised in the FNC (which also has personnel with experience of participatory work), the FNC's participative and collaborative action in implementing environmental protection and rehabilitation would need to be further emphasised and encouraged.

### 6.7.5. Local women and participation

Implementing of an environmental programme with women's participation would require consideration of several specific issues in the study area. Identification of these issues and, particularly, solutions for them can be based on the circumstances in the study area and also, on experiences from elsewhere. Chapter 2.2.5. presented factors that had encouraged women's participation in India, such as including them in the programmes from the beginning, involving gender-sensitive officials and NGOs in the programmes and involving large numbers of rural women in projects. Women had been also most vocal and active in groups consisting solely women (Agarwal 1997b, 31-37). These practices could also be perhaps applied successfully in the present study context; in fact, FNC employers already include some gender-sensitive women professionals, and the farmer women are already used to participate in community discussions and they have a women's group in their village. Thus, some institutional capacity exists in the FNC, and the social structures in the farmer village seem to be beneficial for farmer women's participation.

Environmental intervention should also recognise that there are several issues that affect all women as a group, when, at the same time, the rural women's situations differ from each others. The situations of pastoral and farmer women as two groups are different, for the farmer women generally have more visible positions in their communities as compared to the pastoral women. Both groups are affected by the gender-based division of tasks, which means that they share the task of collecting firewood and consequently, activities that reduce the burden of this task such as introduction of fuel-saving stoves, benefit all women.

The majority of the local women, and the farmer women in particular, are also taking care of the farms, fetching water and firewood, and performing the domestic duties (cooking, washing clothes, looking after children etc.). Since women's labour is needed for the provision of the immediate livelihood, labour-demanding activities that do not provide immediate benefits are problematic. Therefore, if the rehabilitation of common property land is conducted with women's participation, they would need to be compensated somehow for allocating their scarce labour for such work.

Furthermore, since the women commonly believe that increased environmental rehabilitation by local people's activities could not significantly improve the environment and their lives, it seems realistic to expect that even most of the farmer women, familiar with planting trees, will not allocate considerable efforts to planting and experimenting with trees even on their households' own lands. Nonetheless, promotion of drought-tolerant, locally valued trees and, perhaps, other attractive (fruit) trees adapted to arid conditions by their *easy availability* would most likely lead to an increase in the farmer women's (and men's) tree planting on homesteads.

Considering the critical need of food, it is perhaps also worthwhile to mention again that farmer women are crop important cultivators and, consequently, their involvement and participation in the increase of cropland production needs to be ensured. The findings of this study suggest that ensuring women's participation would not pose a challenge; women are accustomed cultivators and have an interest in improving their households' well-being. For example, in families where the use of *neem* (*Azadirachta indica*) against pests was known, both women and men had adopted this practice. Thus, farmer women have central roles in the everyday management of croplands, which is why it is natural that they quickly adopt beneficial techniques to improve the croplands. The main, final decision-making power of what to cultivate is nevertheless mostly held by the men.

It was earlier suggested that the support for income generation would be targeted most of all to the poorest women. When considering their participation in

development activities, it needs to be recognised that the poorest women are also most vulnerable for poor health and depression. The poorest female-headed households face added constraints, because they rely solely on women's labour. This is why it is also particularly difficult for them to conduct any activities without immediate concrete livelihood benefits. Consequently, there is a risk that the poorest women would be less eager or able to participate in the planning of income generation, as compared to the wealthier women who have more flexibility in their time use. Furthermore, some women are likely to be naturally more "business-oriented". An issue to consider is to what extent to provide support to such women who have the most ideas, time and motivation to work for them, and to what extent to focus the support to the poorest who are likely to need additional encouragement to participate in a development intervention and are in the deepest need for additional income.

One approach would be to encourage cooperation between various women by forming women's groups. Forming of a women's group in conjunction with income generation seems to "fit" particularly to the farmer village that already has a women's group for organising various events in the village. The farmer women have also participated in decision-making in their villages and they are perceived as capable of working for the well-being of the community (chapter 5.6.2).

The nomadic pastoralists do not have women's groups, and they were clearly less visible in their communities as compared to the farmer women. This is why it would perhaps require more efforts to establish active women's groups among the pastoralists, which could perhaps cooperate in conjunction with income generation activities or introduction of fuelwood saving stoves. On the other hand, many pastoral women are used to organise their daily lives rather independently when their husbands are away herding animals, and they also conduct together daily activities such as fetching water and fuelwood. Hence, the idea of forming women groups in connection with development activities might not be so foreign to the pastoral women after all.

Forming women groups "officially" in development programmes could perhaps make the pastoral women more visible in their communities and even perhaps empower them in the future whereby they would have a more significant role in communal decision-making. If women's cooperation would occur in conjunction with income generation, it could increase their economic power in the family and also empower them this way. Also among the farmer women, the increase of women's cooperation and creation of new women's groups would perhaps strengthen their positions in their families and their villages, empowering them further.

### 6.7.6. Support to multisectoral development

It has been proposed that if the local perceptions of the most urgent development needs of the study area would be respected, environmental rehabilitation as such would not be prioritised as the main goal of an environmental project, which would rather concentrate on improving the local food security and livelihoods. So far, this research report has discussed the constraints and options for a gender-sensitive environmental intervention in the study area when particularly these needs would be recognised.

At the same time, maintaining a livelihood is affected by many developments in society in different sectors. For instance, to improve the livelihood opportunities of the people studied, social sector should be developed, including such activities as improving the availability of education and health services. Moreover, development of land tenure and economic policies would be also needed, including the development of legislation and the cooperation of different sectors to strengthen the coherence of activities. Hence, many activities are required to improve the food security and livelihood options for the local people that cannot all be accommodated in an environmental, forestry-related intervention alone. However, *the environmental intervention in the study area can take into account the need to develop several sectors, making efforts, whenever possible, to increase cooperation for improving the livelihood of the people.*

## 6.8. Applicability of the study

This research report emphasises that each context has its special characteristics that need to be known, in order to successfully encourage local people to participate in increased protection and rehabilitation of the environment. The present theory took a critical position towards generalisations and emphasised that conclusions about the roles of rural people in environmental changes should be based on adequate knowledge of each context (chapter 2.7.). While the theory acknowledged that generally numerous social and biophysical factors affect people's environmental practices in various areas (see chapter 2.), this study now explored which exact factors had affected people's environmental practices in the study area and how they these factors affected different people there. Hence, due to the nature of knowledge that was sought, the study provides knowledge mainly applicable to the study area.

Nonetheless, even when applied solely to the study area, the study had some limitations. Studying only one farmer community resulted in a situation in which solely this community presented the farmers in the area, when in fact each farmer

village has its own characteristics; for instance, some farmers are involved in the gum arabic trade while others are not. As described in chapter 5.5, the villagers studied most likely also had a rather favourable economic position as compared to villages in general in the area.

However, although the study provided findings of one specific context, it also provided some general knowledge, commonly applicable. In fact, the study can be even used as another "case" to support further the validity of some already widely-presented conceptions and knowledge of the dryland areas of the tropics. Firstly, the central significance of precipitation as it affects the environment and livelihood of people in the drylands became apparent again. Secondly, it was again found that local environmental practices are affected by livelihood-related considerations, gender-affected differences in economic decision-making, cultural factors, and by environmental literacy. Thirdly, it became obvious that the options available for livelihood are affected by many factors in the social context, including government policies and market circumstances. All these findings are likely to be commonly found also in other dry regions of the tropics.

# 7. Conclusions

## 7.1. The roles of rural women in land degradation

### 7.1.1. The occurrence of the phenomenon

It is still extremely difficult, if not impossible, to present conclusions about the exact occurrence and scale of land degradation in the study area. According to the land users, negative environmental changes such as the *reduced vegetation cover and cropland production* complicated significantly the maintenance of their livelihood in the area. Whether a large-scale reduction of cropland productivity has occurred in the farmers' croplands remained, however, a question left unanswered with this research.

At the same time, this study assumed that land degradation occurring in the most affected sites can be identified by observation. Consequently, the study identified such severely affected sites around El Obeid town, in the surroundings of Umm Ruwaba town, around *hafirs,* in an area that had been used for mechanised agriculture and on common property land around the farmer village studied.

### 7.1.2. Pastoralist women's livelihood activities and land degradation

The rural people emphasised that environmental changes in the study area were most of all caused by the decrease of precipitation – although the precipitation statistics from the 20th century did not suggest a decrease in the mean annual precipitation. It is, nevertheless, possible that the variability of the precipitation has increased in the area, causing increased aridity in the croplands, reducing their productivity. This possible increased aridity owing to the increased variability of rain could not be verified in the present study and it also seems impossible to verify it with other research.

The study area has nonetheless experienced environmental changes such as the decrease of trees, which the local population (together with the effects of climate) has caused owing to its current livelihood strategies. In the study area, the environmental impact of the pastoral women's firewood collection was affected by the length of the time during which they moved in the study area each year. The women who lived in camel-herding communities still following a traditional migration pattern, just passed through the area twice each year, while other nomadic pastoralist groups spent several months there; some pastoralists even moved within

the study area throughout the year. Generally, the trend was to spend more time in this area than before; this has led to an increased population concentration and added pressure on natural resources.

*The pastoralist men had the main power to decide on migration and livestock management in the households,* although many women had also been consulted before decision-making. However, the men had to make their livelihood decisions in a certain social and biophysical context that offered them limited livelihood options. Nomadic pastoralism was still the learned way of life, affecting strongly how the men perceived themselves and their biophysical environment. In addition, the economic opportunities in the study area and the availability of water for people and animals attracted the pastoralists to spend more time in there. Moreover, agricultural schemes and the civil war have prevented some of the pastoralists from using their former pastures located south of the study area and encouraged their prolonged stay in the study area. Furthermore, the extremely severe drought of the 1980s had caused long-term catastrophic effects, including the loss of a vast number of animals, which is why some traditionally frequently-migrating, non-cultivating camel herders have made modifications in their livelihood strategies.

Although the pastoralist women affected the environment mostly by collecting firewood, it was normally collected in a manner that minimised its environmental impact, breaking the branches of trees by hand and using only a part of the tree. They also preferred deadwood when available. Sometimes the firewood was, however, cut more intensively by the poorest pastoral women who had to trade fuelwood in order to earn income for their families.

Gender also allocated the pastoral women the responsibility of hut construction, which required building poles. Cutting of poles affected the tree cover in the study area, but the significance of this activity in land degradation seemed rather limited, as the poles were used as long as they lasted and durable poles were also bought. Moreover, increased commoditisation had increased purchasing commodities from urban centres, diminishing the environmental impact of pastoral women's carpentry and handicraft activities.

### 7.1.3. Women farmers' livelihood activities and land degradation

The farmer women cut some firewood on their private farms, but most of the wood was cut from common property land. The farmer women's cutting of firewood for private use affected the environment more, since they lived sedentary lives and cut the tree branches with axes. At the same time, the farmer women's tendency to use

dry and deadwood when available, alleviated the environmental impact of their firewood collection.

Gender did not allocate the farmer women carpentry tasks or the responsibility to build huts, although they did some building and, particularly, assisted the men by collecting building material. Cutting trees for building poles might have caused intensive cutting or even felling of trees, leading to land degradation in some sites, but the poles for construction were not needed constantly.

The farmer women affected the land as cultivators, practising mostly an agroforestry system with rehabilitative farming techniques. Nevertheless, poverty forced some women to cultivate the croplands with reduced fallow periods, which probably caused land degradation on some farmlands.

Female-heads of households decided about their households' cropland use, and many women in male-headed households also managed independently small, inherited plots. At the same time, in most families *men made the final decisions on the cropland use* –but normally often after they had consulted their wives and other family members.

Most of the families relied on agricultural crop cultivation as the main source of livelihood, but it was often combined with other sources of income. The price paid for *gum arabic* and agricultural produce was an important matter that had been considered in conjunction with the allocation of land for different crops. Households also tried to minimise the risks. The main risk was to loose the harvests because of insufficient rainfall, which is why several crops with varying levels of drought resistance were cultivated. Government policies and markets played important roles in land-use decisions, also affecting the price that small producers received for different crops.

The farmer women had a varying direct impact on the environment. The majority of the women, who cut trees only for private use and practised agroforestry with long fallow, affected the environment least. The poorest female-headed households appeared to affect the environment most severely; they decided on their cropland use and they cultivated intensively in order to survive in the short term and they were also obliged to cut trees in order to sell fuelwood.

Therefore, *when the focus is solely on the women's direct interaction with the biophysical environment, it can be concluded that they had variable, but normally limited roles in land degradation.* Generally, women's most significant environmental activity was that of

cutting trees, which was likely to contribute, at least in some places, to land degradation, affecting the environment together with the climate and livestock.

However, *when a wider perspective is taken, it becomes questionable whether the women played roles in land degradation at all.* Gender, poverty and the need to maintain a livelihood caused them to conduct environmentally harmful activities whose impacts on the environment were worsened by the fluctuating precipitation. They had, however, no power to change these causes of their harmful environmental activities.

## 7.2. Rural women and forestry-related intervention in the study area

New efforts to diminish the local women's harmful environmental impacts would need to focus on developing both the biophysical and the social environment. From a livelihood perspective, *the inadequate availability of food* seemed to be the most critical problem in the study area. Therefore, an increase use of organic fertilisers could be supported in order to improve productivity of croplands. Moreover, it was also suggested that the applicability of the scientifically-acquired knowledge of increasing the gum arabic production with certain measures, would be further discussed and explored with the farmers.

The most effective manner to protect the natural resources in the study area would perhaps be the provision of income-generating activities specifically for the poorest families which are obliged to cut trees in an intensive manner in order to trade fuelwood for their livelihood. Furthermore, fuel-saving stoves would decrease the pressure on the environment and alleviate women's work burden.

Farmers have already experience on tree planting in the private land and increased planting could be encouraged with easier availability of tree seedlings. Planting of trees on common property land is extremely demanding in the study area. The scarcity of land is a problem and all local land users should agree on such land use.

Local people, and the women in particular, now have to allocate their scarce labour to maintain immediate livelihood. They do not prioritise environmental rehabilitation as a development need, and in their view trees take a long time to mature. Therefore, they have to be provided with incentives if trees are to be planted on common property land – which might affect the long-term sustainability of such activities.

The study found that the farmers preferred most the following tree species: *Acacia senegal*, *Azadirachta indica*, *Balanites aegyptiaca*, *Compretum* sp. and *Ziziphus spina-christi.* The nomadic pastoralists preferred *Balanites aegyptiaca, Grewia tenax*, *Ziziphus spina-christi, Cordia sinensis* and *Adansonia digitata*. Particularly the nomadic women also preferred trees used for cosmetic purposes, including *Combretum spp.* species and *Acacia seyal*.

Experience from elsewhere suggests that including a large number of women in a community-based environmental programme would make them more courageous to participate actively and vocally. In fact, since women's groups seem to offer a tool for empowerment women, formation of such groups would perhaps also be worthwhile in the study area. The farmer women participated in the communal decision-making and they had already formed a women's group in the village studied. Thus, forming women's groups in connection with an environmental programme would agree with the farmers' current social structures and their gender-related perceptions of women's roles. In contrast, the pastoral communities lack such social structures and in them the women are less visible. Forming women's groups could be, however, worthwhile also to discuss with pastoralist women who then could perhaps work together particularly in income-generation activities.

Finally, forestry-related environmental intervention in the study area can address some local livelihood needs, but it cannot accommodate the numerous development activities needed to improve local welfare and livelihoods. Forestry-related environmental intervention thus needs to be implemented with readiness to co-operate with other development programmes, such as programmes in the health and education sectors.

"*Education brings light to the people*!"
*Sheikh* of a *Hawazma* pastoral community

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APPENDIX 1: Questions for nomadic pastoralists

*A. Background information*

1. Name
2. Sex
3. Ethnic group
4. Religion
5. Age
6. Education
7. Who belongs to your household?
   - How many adults and how many children? Their ages?

*B. Production system*

9. Does your family keep animals? Which? How many of each?
10. Does your family cultivate part of the year in this area?
11. If yes, how did you get your land (rented, bought, inherited)?
12. What kind of soil is it on?
13. What crops do you cultivate at the moment?
14. Do you have trees in your agricultural land? Which trees? Do they grow separately and/or with agricultural crops? Describe the farming system (do you burn the land, for how long do you cultivate the land, how long is the fallow, do you use intercropping or other methods to conserve/rehabilitate the land)?
15. Do you yourself do all these activities or are they divided in your family? Who decides about the agricultural crops in your family? Do you discuss about it?

*C. Environmental changes*

16. Have you moved in this area for a long time or are you new here?
17. Has this environment changed over the years? How?
18. Why have the changes occurred?

*D. Environmental rehabilitation*

19. Which five tree species do you prefer the most in this area and how do you use them?

20. What methods can people use here to prevent environmental changes and/or repair degradation?
21. Have you used any of those methods personally? Which? If not, why?
22. Have you and/or any other member of your family planted trees? Which? Where?
24. What was the main reason for planting? Where did you get the seeds/seedlings?
25. Have you received any training about environmental activities by "outsiders"? What kind of training?
26. Would you be interested in receiving training on planting trees?

*E. Land tenure and financial decision power*

27. In your family, who decides in your family about buying and selling animals? Do you discuss it together, before the decisions are made? Do you think you personally have power to influence that decision?
28. Describe the sources of income you have. Who uses money in your family and how?

APPENDIX 2: Questions for farmers

*A. Background information*

1. Name
2. Sex
3. Ethnic group
4. Religion
5. Age
6. Education
7. Who belongs to your household?
   - How many adults and how many children? Their ages?

*B. Production system*

9. How much land does your household have altogether?
10. How did you get your land (rented, bought, inherited)?
11. What kind of soil do you have in your cropland?
12. What crops do you cultivate at the moment?
13. Do you have trees in your agricultural land? Which trees? Do they grow separately and/or with agricultural crops? Describe the farming system (do you burn the land, for how long do you cultivate the land, how long is the fallow, do you use intercropping or other methods to conserve/rehabilitate the land).
14. Do you yourself perform all these activities or are they divided in your family?
15. Does your family keep animals? Which? How many of each?

*C. Environmental changes*

16. Are you originally from this village?
17. Has this environment changed over the years? How?
18. Why have the changes occurred?

*D. Environmental rehabilitation*

19. Which five tree species do you prefer the most in this area and how do you use them?
20. What methods can people use here to address to prevent environmental changes and/or repair degradation?
21. Have you used any of those methods personally? Which?
22. Have you and/or any other members of your family planted trees? Which? Where?
23. What was the main reason for planting? Where did you get the seeds/seedlings?
24. Have you received any training about environmental activities by "outsiders"? When?
What kind of training?
25. If yes, do you think that the training could be developed somehow? How?

*E. Land tenure and financial decision power*

26. In your family, who decides what is cultivated? Do you discuss it together, before the decision is made? Do you think you personally have power to influence that decision?
27. Describe the sources of income you have. Who is of charge of selling your crops and/or other sold items?
28. Does anybody migrate from your family to work part of the year elsewhere? Who? Where does he/she go?

APPENDIX 3: Key Informants

1. Abdel Samad, Samira (M.Sc. in Soil Microbiology, B.Sc. in Agriculture). Director in Ministry of Agriculture in El Obeid during the time of the research.

2. Ali, Osama Abdalla. Forest supervisor in FNC in charge of El Ain forest area, who had worked in the study area for 12 years.

3. Ballal, Mohamed El Mukhtar (doctoral degree in forestry). Researcher in Agricultural Research Centre (ARC), El Obeid Research Station.

4. Elagab, Salih Elagab Elsheikh. (M.Sc. in forestry). Researcher in Agricultural Research Centre, El Obeid Research Station.

5. Hussein, Adam Abdalla. Project manager stationed in El Obeid, who worked for the Malaysan African Asian Company Ltd.

6. Ismael, Abdalla. Sheikh of the studied farmer village.

7. Mohamed, Abdalla Gaafar (received doctoral degree in forestry in 2005 from the University of Helsinki). Head of Technical Sector in FNC who lived in El Obeid 2000-2002.

8. Ramli, Fatma. Worked as an extension officer in the UNSO's and FNC's project "Restocking of the Gum Belt for Desertification in Northern Kordofan". After UNSO's funding continued to work with the local communities as FNC's officer. In 2002, during the interviews, was seconded from FNC to direct a company that supported the local farmer's efforts to co-operate in the gum arabic trade.

APPENDIX 4: Valued local trees and their uses

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| 1. *Acacia nubica* Benth. (*la ŧut* in Arabic language)<br><br>Pastoralists: This tree was only mentioned by pastoralists who used its bark to make ropes. The leaves were also used to heal swollen body parts after an injury. Also used as fences for calves. |
| 2. *Acacia mellifera* (Vahl) Benth. (*kitir* in Arabic)<br><br>Pastoralists: This tree was described only by pastoralists who used its leaves for animal forage and its wood for building and firewood. The bark was also used for making ropes and to cure stomach problems. |
| 3. *Acacia nilotica* (Linn.) Willd *(sunt*)<br><br>Pastoralists: This tree was described only by one pastoral woman who used its fruits for colouring goat skins. |
| 4. *Acacia senegal* (L.) Willd (*hashab*)<br><br>Pastoralists: Used its gum to ease stomach pains, for cleaning kidneys and eating like chewing gum. Also valued tree for forage.<br><br>Farmers: Important income generating tree due to its gum. Also used for building, fencing, firewood and charcoal. Valued also for shade and for improving croplands' quality. Valued forage tree. |
| 5. *Acacia seyal* Del. (*talih*)<br><br>Pastoralists: The women used the tree for "fuming" to obtain an attractive skin colour and smell. Also rheumatism was alleviated by "fuming". Valued for firewood due to the pleasant odour. Ate it as chewing gum.<br><br>Farmers: "Fuming" was also conducted by women for a nice skin colour and smell. Preferred firewood. |

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| 6. *Adansonia digitata* Linn. (*tabaldi*)<br><br>Pastoralists: This tree (baobab) was only described by pastoralists who consumed its fruits as such or made juice from them for energy. The juice was also used for stomach problems. Flour was added to the juice to prepare a "small meal". Bark of the tree was also used to prepare robes. Leaves and flowers were eaten by animals. A pastoralist also used its resin to decrease blood pressure. |
| 7. *Albizia lebbek* (L.) Benth (*diqn basha*)<br><br>Farmers: This tree was described solely by farmers. They valued it as shade tree for people and animals, and used it as firewood and charcoal as well. |
| 8. *Anogeissus leiocarpus* Guill. & Perr. *(sahab*)<br><br>Pastoralists: This tree was only described by pastoral women who used for "fuming" to acquire a pleasant smell and skin colour and to treat body pains. Also valued as a forage tree. |
| 9. *Azadirachta indica* A. Juss. (*neem*)<br><br>Farmers: This tree was described solely by farmers who used its leaves to treat malaria; the leaves were either used as such (farmers covered their mattresses and themselves with leaves and slept waiting for the fever go down or the leaves were boiled with water and this "tea" was drunk). Crushed leaves were also placed on wounds to heal them. Some farmers also used it leaves against insects that destroyed crops. Crushed leaves were used in cropland on top of watermelon or in storages to protect all crops from insects. Some people smashed the eaves and boiled them in water and put this solution in a used spray bottle. The solution was then sprayed to destroy insects where needed.<br><br>*Neem* was also an important shade tree for people and animals and amenity tree. Also used for building, firewood and charcoal. |
| 10. *Balanites aegyptiaca* Del. (*higlij*)<br><br>Pastoralists: The fruits provided complementary energy and were eaten as such or juice was prepared. Juice was consumed or a "small meal" was prepared adding flour. Fruits were also used to cure stomach pains, some used the juice to cure |

kidney problems and to treat blood pressure. Oil from the fruits were used for cooking. Each fruit contains a single hard stone that was used to prepare rosaries. Leaves were used as a soap to wash dead before burying and to wash clothes. Leaves were also valued as animal forage.

Farmers: Fruits used to cure stomach pains, leaves used as soap for dead, also valued as building material, for furniture, fence, shade and firewood. Stones from the fruits used for rosaries.

11. *Boscia senegalensis* (Pers.) Lam. Ex Poir. (*kursan*)

Pastoralists: This tree was described only by one pastoral man who used its crushed and boiled bark for heart problems.

12. *Calotropis procera* (Ait) Ait. F. ( *usher*)

Farmers: This tree was described only by few farmers, who used it for firewood and building.

13. *Capparis decidua* (Forsk.) Edgew. *(tundub*)

Pastoralists: This tree was described solely by a pastoral women, who valued the tree for its fruits and leaves that could be foraged.

14. *Combretum spp. (habil, shutah*)

Pastoralists: The most -preferred "fuming" tree of all. The "fuming" produced an attractive odour, skin colour and alleviated women's body aches and fatigue. Due to its odour, it was also preferred as firewood. Women used also its bark to produce dark tanning dye that could be used for handicrafts such as creating dark stripes in straw mats. Valuable forage tree for animals. Used also for building.

Farmers: Women used the tree for "fuming" to produce attractive fragrance and skin colour. Also used for firewood and building.

15. *Cordia sinensis* Lam. (*andarab*)

Pastoralists: Consumed fruits to get energy. Leaves used for animal forage. Bark used for wounds, to heal and to prevent infections. Preferred firewood due to its pleasant odour. “Fuming” provided perfume for women.

Farmers: Used the tree for building. Fruits were also eaten by people and bark used to heal wounds.

16. *Dichrostachys cinerea* (Linn.) Wight. & Arn. (*kadad*)

Pastoralists: This tree was described only by few pastoralists who valued it for its leaves and fruits that were eaten by animals. A pastoralist woman also valued it particularly for its odour that was released when burned. She had used it for firewood and burned this tree inside a pot for milk to acquire a nice odour for the pot after the milk has been kept there.

17. *Faidherbia albida* (Del.) A. Chev. or Acacia albida Del. (*haraz*)

Pastoralists: This tree was only described by a pastoral man who preferred it furniture.

18. *Gargadan* (scientific tree name unknown)

Pastoralists: This tree was described by pastoralists only. They used its fruits as such, as juice or to make "a small meal" by adding flour. The juice was also given to the sick to get tem stronger. The fruits could be also used to sweeten cow's milk. The juice was also given to cow after she had given birth. Leaves foraged by animals.

19. *Grewia flavescens* Juss. (*khelisan*)

Pastoralists: Described only by pastoralists who valued the tree for its fruits. Fruits were consumed as such, as fruits and as a "small meal" with flour added to the juice. Forage tree for animals.

20. *Grewia tenax (Forssk.) Fiori* (*gudim* )

Pastoralists: Ate fruits for energy or prepared juice from them, which was believed to "decrease blood poverty". Juice was also consumed to prevent malaria and taken during malaria. When flour was added to the juice, it provided a "small meal". Leaves were valued as animal forage.

Farmers: Fruits were eaten or used for juice. Juice was consumed to give energy and to provide vitamins for the sick.

21. *Guiera senegalensis* J.F. Gmel. (*qubaish*)

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| Pastoralists: Used the leaves for stomach pains and kidney problems.<br>Farmers: Used tea from its leaves to cure problems in some specific body organs. Boiled leaves also used to cure malaria. Used for building. |
| 22. *Leptadenia pyrotechnica* (Forsk.) Decne. (*marekh*)<br><br>Farmers: Only described by one farmer man, who used it to make ropes and in building. |
| 23. *Nagil* (scientific tree name is not known)<br><br>Pastoralists: This tree was described solely by a pastoral man. He valued it for its fruits that could be eaten as such for energy or could be consumed as juice. Juice was also beneficial for the stomach. Also valued as fodder tree. |
| 24. *Tamarindus indica* L. (*aradib*)<br><br>Pastoralists: Only described by pastoralists. They ate the fruits as such or prepared juice from its fruits that was taken against malaria. Also valued as a forage tree. Moreover, *Fellata* pastoralists described that they had used its wood to prepare durable pots in which sesame seeds and groundnuts were pressed to produce oils. |
| 25. *Tugur* (scientific name not known)<br><br>Pastoralists: Only described by pastoralists, who used the fruits. When flour was added a "small meal" could be prepared. The juice was also used to treat the sick, it also gave energy and made the pregnant women feel better when drunk in the morning. Fruits and leaves were also eaten by animals. The women also burned this tree to acquire a nice skin colour |
| 26. *Tugga* (scientific name not known)<br><br>Pastoralists: This tree was described by a pastoral man who ate its fruits and made ropes from its bark. He also valued it as a forage tree. |
| 27. *Umm baijud* (scientific tree name not known)<br><br>Pastoralists: Solely one pastoral woman described this tree she had used for "fuming" to get a nice skin colour, odour and to treat rheumatism. She valued it also as forage tree. |
| 28. *Umm dieka* (scientific name unknown) |

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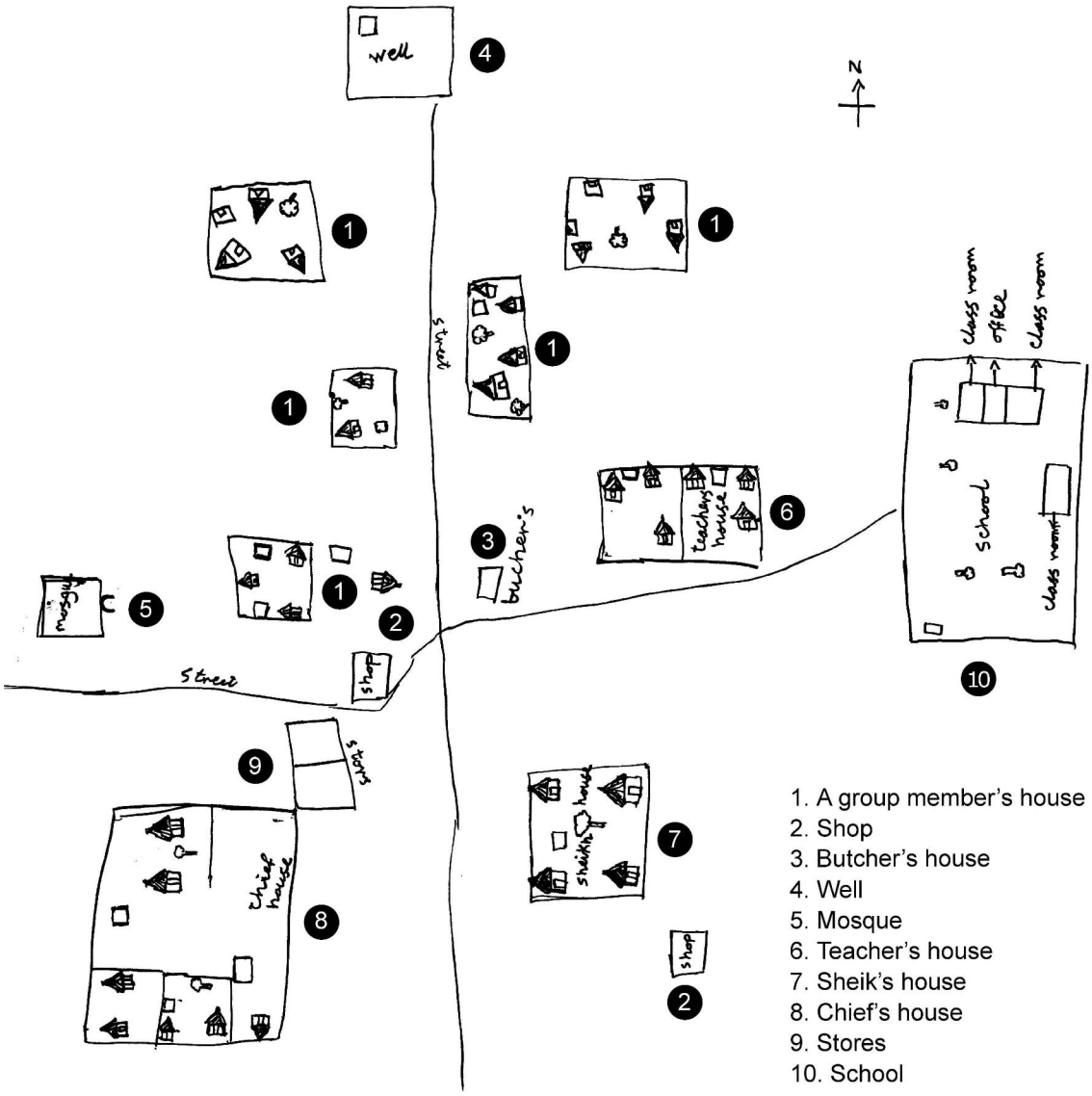
| Pastoralists: A pastoral woman brought up this tree, because it has sweet fruits that children like to eat. |
| 29. *Umm efin* (scientific name not known)<br><br>Pastoralists: This tree was only described by one pastoral man. He valued it as a forage tree and also used its leaves to cure swollen parts of the body. |
| 30. *Ziziphus spina-christi* (L.) Desf. (*sidr*)<br><br>Pastoralists: Fruits provided complementary energy and were used to cure stomach problems. Animals liked the fruits. Leaves were valued as animal forage and used to wash the dead. Heart pains were treated with boiled leaves or with bark, which was boiled or was crushed and consumed raw. Also roots were used for stomach problems.<br><br>Farmers: Consumed fruits to get energy and sold fruits for income. Leaves were used to wash the dead, to wash hair as well as to cure wounds and body aches. Valued tree for building and used for animal fences. |

APPENDIX 5: Map of the farmer village



APPENDIX 6: Seasonal calendar of the farmer women

| **Activity/ Month** | **May** | **June** | **July** | **Au** | **Sep** | **Oct** | **Nov** | **De** | **Ja** | **Fe** | **Ma** | **Ap** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Collecting firewood and water, cooking, childcare, washing and ironing | x | x | x | x | x | x | x | x | x | x | x | x |
| Cutting the grasses and burning the farmland | x | | | x | | | | | | | | |
| Growing of crops begins | | | x | | | | | | | | | |
| Weeding | | | | x | x | | | | | | | |
| Harvesting | | | | | | x sesa-me | x karkadeh | | | | | |
| Selling the crops | | | | | | x | x | x | x | x | x | x |
| Preparing handicrafts | x | | | | | | | | x | x | x | x |
| Collecting gum arabic | | | | | | x | x | x | x | x | x | x |
| Collecting straw | | | | | | | | x | x | x | x | x |
| Collecting wood for building | | | | | | | | x | x | x | x | x |
| Selling fruits of *Ziziphus spina-christi* | | | | | | | x | x | x | | | |
| Building fences around homesteads | | | | | | | x | x | x | x | | |
| Harvesting of *Sorgum bicolour* | | | | | | | x | x | x | x | | |